Swan and Canning Rivers Foreshore Assessment and Management Strategy

March 2008

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Preface

1.1 The Swan River Trust

The Swan River Trust works in collaboration with the Commonwealth and various State, and local government agencies, community and industry organisations to deliver two important outcomes:

1. The long-term community benefit of the Swan Canning river system is protected and enhanced; and
2. The ecological health of the Swan Canning river system is protected and enhanced.

The replacement of the *Swan River Trust Act 1988* and the *Environmental Protection* (*Swan and Canning Rivers*) *Policy 1997 with* the *Swan and Canning Rivers Management Act* (*proclaimed September 2006*) improves the State's ability to manage activities that may affect the Swan and Canning rivers. This will enable management issues such as maintaining biodiversity, facilitating commercial and recreational use of the waterways, and conserving indigenous and European heritage to be more effectively addressed.

The new legislation recognises the importance of the rivers as an icon of Perth by establishing the Swan Canning Riverpark. Riverpark consists of the waterways and adjacent Crown land reserves of the Swan, Canning, Helena and Southern rivers (private property is not included in Riverpark). The legislation makes the Trust responsible for the waterways, establishes joint management arrangements for shorelines, and requires preparation of a Riverpark Management Program to integrate management of the waterways and the adjacent reserves along the foreshore.

Since January 2002, the Trust, through its River*bank* Program, has worked with local and State government land managers to initiate foreshore protection and rehabilitation projects within its management area. The Trust will contine to work in partnership with local and State government to maintain and improve Riverpark foreshore areas.

1.2 About this Document

The Swan River Trust has long recognised that to effectively manage the Swan Canning foreshores and allocate investments, a good understanding of the foreshore condition and threatening processes is required. In 2002, the Trust successfully sought funding through the Natural Heritage Trust to undertake an ecological and physical assessment of the Swan Canning foreshores and subsequently established a 'Foreshore Assessment' project in partnership with the Swan Catchment Council. That project was aimed at:

- identifying condition and pressures;
- making recommendations for management;
- identifying priorities for investment; and
- providing a benchmark for future evaluation.

This document represents a culmination of that project and is divided into two major parts. The first part summarises the findings of the Foreshore Assessment, describing foreshores, their pressures and condition. The second part of this document is a management strategy which summarises the foreshore issues, defines management responses and identifies priorities for action.

Throughout this document, the riverbanks and shorelines are considered separately from the foreshore vegetation. This is deliberate and consistent with the two objectives of the Swan River Trust's River*bank* Program:

- To protect and enhance riverbanks and shorelines to mitigate threats to foreshore values; and
- To protect, enhance and manage fringing indigenous vegetation and habitat.

The Foreshore Strategy is intended as a guide for investment. It is neither an investment plan, nor a strategic plan for the Trust as a whole. Recommendations of the Foreshore Strategy will be considered and implemented through the Trust River*bank* Program under the Healthy Rivers Action Plan, and also through the Swan Catchment Council investment plans for the NHT3. Implementation is also through existing State and local government plans and community action plans.

The Foreshore Assessment accounts for the current condition and pressures on riverbanks and shorelines and their associated vegetation. Management strategies are focussed on addressing these. The Foreshore Assessment, and thereby the Strategy, does not account for the potential impacts of climate change.

It is too early to reliably anticipate the pace of any systemic change that will be forced by climate. However, it is expected that climate change will result in increased sea levels and storm surges within the Swan and Canning rivers. Therefore, the risk of erosion or inundation in some areas would be expected to increase beyond that identified in this document. In areas where that risk is high, it will become increasingly important to ensure that infrastructure is adequately protected, and to improve the stability of shorelines using appropriate techniques where necessary. It will also be important to ensure that adequate setbacks are in place to enable the shorelines and associated vegetation to adapt to the physical changes that they will encounter.

Climate change is also likely to exacerbate sedimentation where streamflows decline, thereby increasing pressure on areas where this problem already exists. In addition, climate change is likely to change the distribution and abundance of fringing vegetation from which is recorded here.

An important recommendation of the recent report on climate change in the Swan and Canning rivers (Technical Advisory Panel 2007) was the need for an assessment of the vulnerablility of foreshore areas to provide the basis for determining future planning setbacks, managing foreshore vegetation and erosion, and designing erosion control measures. This document and the associated database provide the benchmark against which future change can be measured and vulnerability under different scenarios evaluated.

2 Executive Summary

The Swan and Canning Rivers Foreshore Assessment divided the river into three zones (Figure 2.1). The zones are:

1. **Estuary:** Perth and Melville Waters downstream of the Causeway and Mount Henry Bridges (Zone 1);
2. **Swan:** Swan, Helena and Lower Avon rivers upstream of the Causeway and within the Swan River Trust Management Area (Zone 2); and
3. **Canning:** Canning and Southern rivers upstream of Mount Henry Bridge within the Swan River Trust Development Control Area (Zone 3).

In each zone, the condition and pressures of the shoreline (both built and non-built) and vegetation were documented. Information compiled as part of the Foreshore Assessment was then used as the basis for developing a management strategy. The strategy makes recommendations for management response within two overarching objectives, which are:

- To protect and enhance riverbanks and shorelines to mitigate threats to foreshore values; and
- To protect, enhance and manage fringing indigenous vegetation and habitat.

Within the first objective the term 'shoreline' is defined as the area two metres either side of the high water mark (*Swan Canning Rivers Management Act 2006*). This is used in combination with the term 'riverbank' to acknowledge the spatial extent of foreshores and their values.

The strategy also identifies priority areas for management investment. In considering these, the Trust has adopted the stream restoration principles (Rutherford *et al.* 2000) and taken into account factors such as value, condition and the potential for deterioration or threat. These factors are considered differently for the two objectives. For riverbanks and shorelines, adjacent infrastructure, recreational amenity (including parklands) and environmental values are considered in determining priorities. To set priorities for fringing vegetation and habitat, the environmental values – conservation and biodiversity – are given precedence.

2.1 Riverbanks and Shoreline Issues

Problems related to foreshore stability can be grouped into four broad categories:

1. Inadequate foreshore setback: when development occurs too close to the river in areas where the bank is highly susceptible to external loads such as river flow or inundation;
2. Inadequate natural stability: when bank structure is reliant on small internal features, particularly those susceptible to change, such as a bank maintained by tree roots;
3. Disturbance of sediment transport patterns: susceptibility to external changes in sediment transport and sediment supply; and
4. Inadequate structural stability: the performance of engineered structures (type, condition and function) to ensure ongoing foreshore stability. This is anticipated to be a less significant problem in the Swan and Canning than in the estuary as there is a smaller area of reclaimed foreshores.

Foreshore instability is generally only a concern when the instability threatens infrastructure, recreational amenity, and public safety, environmental or economic values.

An overview of the spatial coverage of these issues within each zone is provided below.

2.1.1 Inadequate foreshore setback

Estuary foreshores are susceptible to inundation as a result of coastal flooding, which includes tides, surges and wave action. One of the most significant problems within estuary foreshores is the insufficient setback of infrastructure. This is of particular significance in low-lying and reclaimed areas of foreshore, and locations subject to natural shoreline fluctuations.

There is a history of constructing built structures along the estuary to stabilise the foreshore position for situations with insufficient setback, in addition to sustaining the location of reclaimed foreshores / dredged channels.

Almost all riverine reaches downstream of the scarp are susceptible to flood risk, dependent on bank elevation and distance downstream. The low-lying regions where rivers and brooks converge are the most susceptible to inundation by floodwaters. The Swan experiences more significant river flow than the Canning, as the main tributary of the Swan (the lower Avon River) has no flow regulation structures. The region most susceptible to flooding is the Swan River between the Causeway and Bells Rapids. The Canning experiences lesser flows as many of the tributaries are dammed (notably, both the Canning and Southern rivers). This results in flood water elevations increasing with distance downstream of the Canning / Southern River confluence, to where the river widens at Riverton Bridge.

2.1.2 Inadequate natural stability

The foreshore and banks are susceptible to a variety of forcing mechanisms across the study area. The estuary foreshore is susceptible to seasonal variations in water level change, wave action, and imbalance of sediment supply versus transport, vegetation loss and tidal currents. The banks along the Swan are susceptible to river flow and boat wakes, resulting in more active banks with greater levels of erosion than along the Canning (Table 2.1). This table quantifies the proportion of foreshore erosion within a defined reach as follows: low (<33%), moderate (33-67%) and high (>67%). The majority of banks within the Canning exhibited a low level of erosion extent. Evidence of upper shore scarping was more evident along the Swan as this experiences a less regulated flow than the Canning.

Table 2.1 Bank erosion along the Swan and Canning rivers

	Low (<33%)		Moderate (33–67%)		High (>67%)	
Zone	km	% Zone	km	% Zone	km	% Zone
Swan	43.6	31%	**53.5**	**39%**	41.5	30%
Canning	**30.9**	**47%**	27.7	42%	7.6	11%

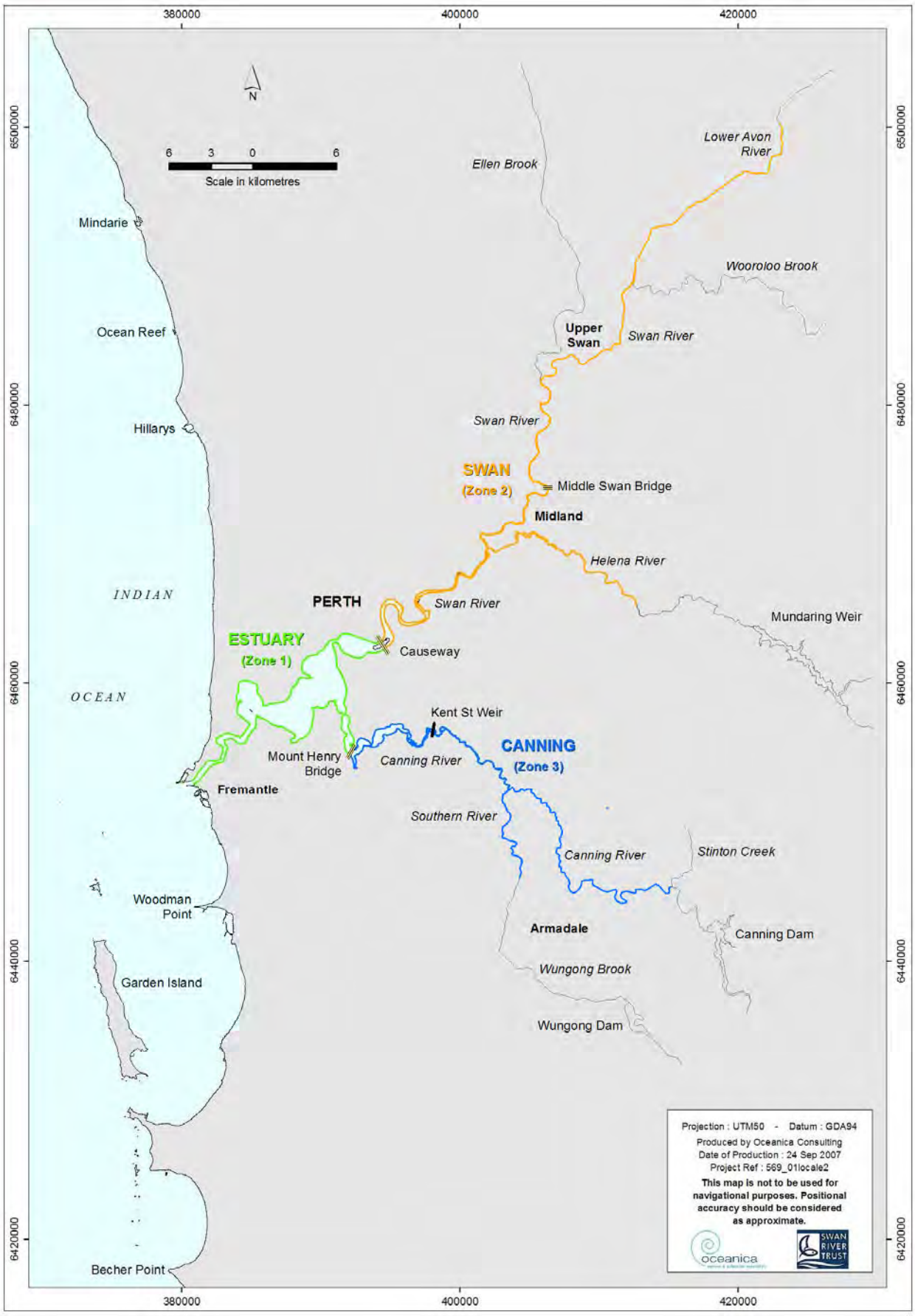


Figure 2.1 Foreshore assessment zones

The presence of trees can increase the foreshore stability as the roots reduce the sediment mobility. The majority of banks along the Swan and Canning are strengthened by the presence of vegetation. However, in many areas there is a single-line of trees (mainly the Swan) or opportunistic invasion of weeds (mainly the Canning). The foreshores in approximately 40 per cent of reaches along the Swan and 26 per cent of reaches along the Canning would be strengthened by significant revegetation. Some of the shore locations within the estuary are strengthened by the presence of sedges and trees, though the influence of vegetation on foreshore stability is not as widespread as the upper river zones.

2.1.3 Disturbance of sediment transport patterns

Drains can have significant impacts on foreshore stability. This is due to the switching between erosive flow and no flow, and the discharged sediment loads. A total of 684 discharges were recorded during the assessment (Table 2.2). Many of these drains discharge directly onto or above the bank and have resulted in significant bank retreat. Erosion associated with drainage outfalls may also extend beyond the immediate vicinity of the drain flow path. This is particularly true along foreshores with active sediment transport. Sediment may be scoured at the drain discharge point during high flow events and the subsequent scour hole may be in-filled by material sourced from other areas during periods of low flow. Uncontrolled drainage has affected bank stability along the Swan and Canning due to runoff over banks and increased sediment supply to the rivers.

Sedimentation decreases the channel's capacity to transport water, resulting in decreased flow speed and increased inundation levels as the channel depth decreases. This is likely to result in increased flooding, increased bank migration and could cause the channel location to fluctuate. Sedimentation on the Swan River was evident immediately downstream of the scarp through to Ellen Brook. Over time, this sedimentation may increase in magnitude and extend further downstream from Ellen Brook. Sedimentation is anticipated across the regulated Southern, Helena and upper Canning rivers. Sedimentation was also observed on the Canning River between Bickley Brook and Southern River.

Table 2.2 Drainage summary

Zone	Drains	Drainage channels	Trib-utaries	Total dis-charges	Drains / channels causing impacts		Drains with features to reduce impacts	
					Number	%	Number	%
Estuary	313	-	-	313	N/A	N/A	N/A	N/A
Swan	140	38	19	197	132	74%	83	47%
Canning	127	37	10	174	127	77%	86	52%
Total	580	75	29	684	-	-	-	-

Note: N/A–not assessed using comparable method.

2.1.4 Inadequate structural stability

A total of 29.7 km of foreshore structures (i.e. river walls, revetments, gabions etc.) were assessed across the three zones. The majority (21.8 km) of structures were located along the estuary foreshore and these structures were generally in a fair condition (54 per cent), with fair to good function (86 per cent) (Table 2.3). The general age and lack of maintenance of the structures is considered an issue, as maintaining the foreshore position is often dependent on the structure.

A total of 6.7 km of foreshore structures on public land were assessed along the Swan. Some 40 per cent were in fair condition, with 40 per cent exhibiting poor function (Table 2.3). This can be largely attributed to the age of the structures, insufficient maintenance and inappropriate height / type of structure for the processes prevailing at that location. Half of the structures assessed along the Swan required immediate maintenance, with one-third of the structures requiring rebuilding or replacing (either with new structure or other alternative, e.g. revegetation and bank sloping).

Of the 1.1 km of structures assessed in the Canning, 42 per cent were in good condition, with 56 per cent exhibiting a good function (Table 2.3). This adequate condition and function can be largely attributed to the recent age of the structures and significant reduction in river flow processes due to dam construction, reduced river discharge, groundwater abstraction and changing land-use patterns. The majority of structures assessed along the Canning required no urgent works.

Table 2.3 Structure condition and function summary

	Condition			Function		
Zone	Good	Fair	Poor	Good	Fair	Poor
Estuary	17%	54%	29%	46%	40%	14%
Swan	27%	40%	32%	30%	30%	40%
Canning	42%	39%	19%	56%	40%	4%

2.2 Vegetation Issues

Over the entire area surveyed along the Swan and Canning rivers, only 527 ha (20 per cent) of the foreshore vegetation was considered in good condition. Another 1278 ha (50 per cent) was considered to be in moderate condition with the remaining 30 per cent in poor condition (Table 2.4).

The Canning foreshores contributed the largest area of good condition vegetation (252 ha), which is concentrated within regionally significant areas of the lower Canning River. Approximately 30 per cent of vegetation within the Canning foreshore was in good condition, with the majority of the area in moderate condition 40 per cent and the remaining 30 per cent in poor condition.

Good condition vegetation occurred within only 14 per cent of the Swan foreshore and was scattered across the lower Swan River, with a few sites along the Helena River foreshore. The mid to upper Swan and lower Avon River foreshores were characterised by predominantly moderate condition vegetation, with areas of the mid Swan foreshore being in poor condition.

Overall, the estuary foreshore contained little vegetation that was in good condition, with the majority of sites being in either poor or moderate condition.

Table 2.4 Comparison of vegetation condition between zones

Zone	Good area (ha)	Moderate area (ha)	Poor area (ha)	Total area (ha)
Estuary	69 (18%)	138 (36%)	170 (46%)	377
Swan	206 (14%)	812 (58%)	386 (28%)	1404
Canning	252 (30%)	328 (40%)	250 (30%)	830
Total	527	1278	806	2611

Moderate condition vegetation often occurs within parkland reserves that have extensive exotic grass understoreys and overstorey vegetation in various states of modification. Poor condition vegetation often corresponded to open grassland playing fields or areas of historic grass pasture. However, a considerable extent of foreshore also includes natural areas in various states of degradation.

The most significant impact on remaining natural areas is weed invasion. Dominant weeds often include grass species, which tend to be varieties of turf species around parklands and reserves concentrated lower in the system and around areas of high residential encroachment. Pastural species dominated in the mid to upper reaches where the emphasis has been on agricultural use. The dominance of grasses as a structural layer was most significant along the estuary and the Swan foreshores (Figure 2.2). While native grasses do persist within the foreshore reserves, they were generally poorly represented in comparison to exotic species.

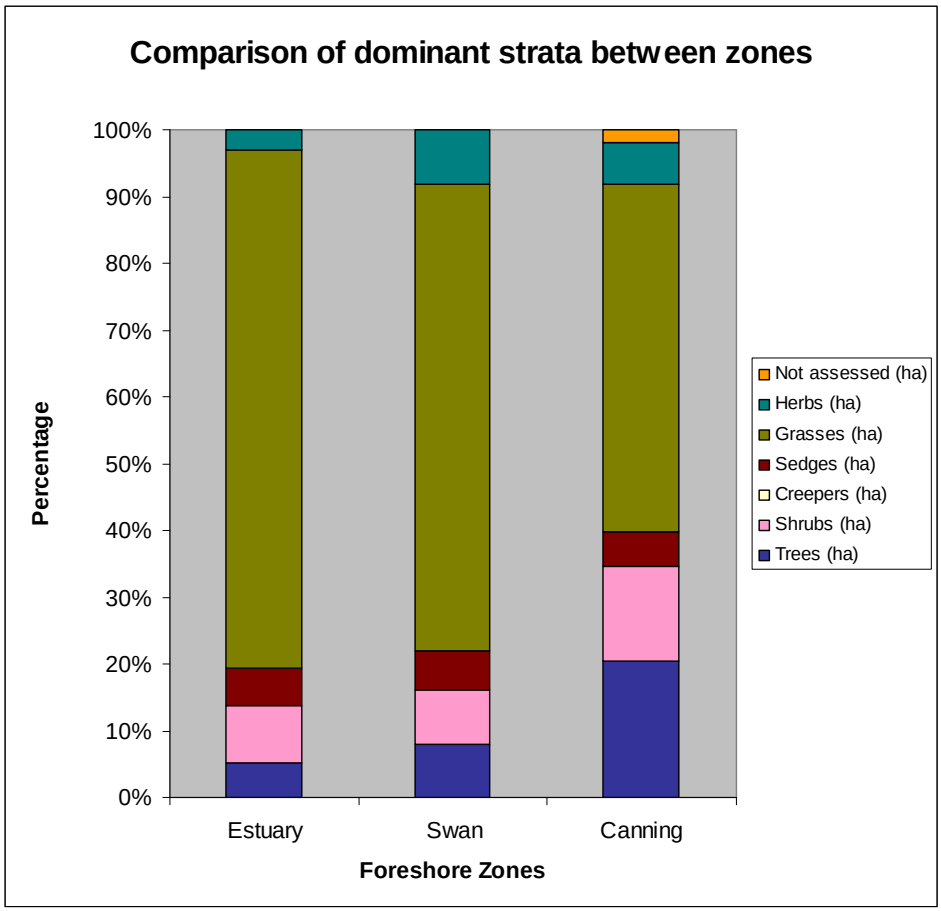


Figure 2.2 A comparison across zones of the percentage of foreshore where each vegetation strata is dominating the vegetation

The majority of vegetation within the surveyed area could be described as moderate to high weediness, with very few areas considered to have relatively low weed cover (Figure 2.3).

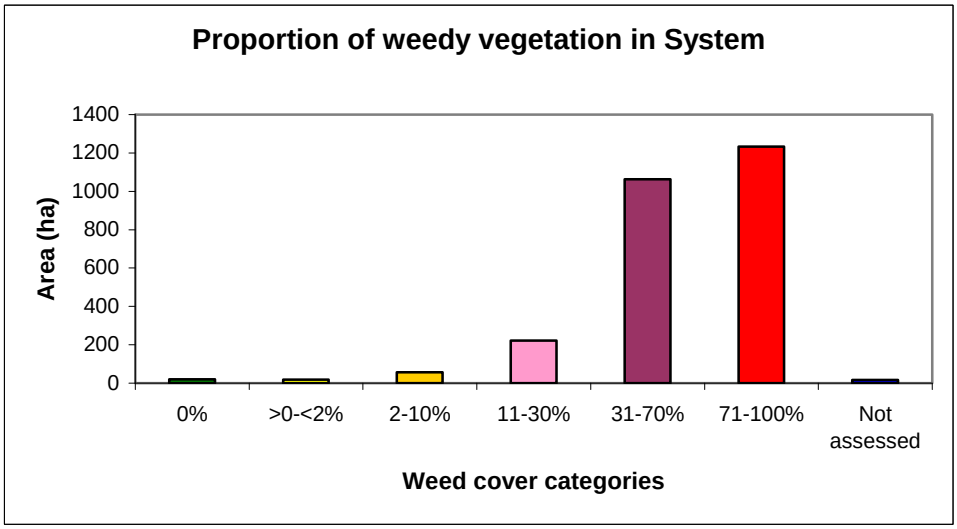


Figure 2.3 Overall area (ha) of vegetation within each weed cover category

A large variety of weed species was recorded across the system. A list of 44 invasive species were specifically recorded because of their status as invasive weeds and their risk to vegetation along the Swan Canning system. Watsonia (*Watsonia meriana*) was most prevalent across the

total area, concentrated predominantly along the upper Swan River and lower Avon River where it forms dense and extensive monocultures.

Eastern states Bulrush (*Typha orientalis*) was the second most prevalent of the invasive weed species overall, and was also the second most dominant invasive along the Swan and the fifth most invasive weed of the Canning (Table 2.5). Perennial veldt grass (*Ehrharta calycina*) was a consistent threat within the top five species list for all three zones. Soursob (*Oxalis pes-caprae*) was a more significant issue for the Swan and Canning Blackberry (*Rubus* spp.) was the dominant invasive species for the Canning, but was not recorded along the estuary and was a less significant threat along the Swan. Numerous species were recorded consistently across all three zones, but represented a lower level of impact in terms of total area covered.

Table 2.5 Five most invasive weed species across the Swan and Canning rivers

Common Names	Species Name	Area (ha)	% Area
Watsonia	*Watsonia meriana*	153	5.8
Eastern states Bulrush	*Typha orientalis*	73	2.8
Perennial veldt grass	*Ehrharta calycina*	68	2.6
Soursob	*Oxalis pes-caprae*	65	2.5
Blackberry	*Rubus* spp.	63	2.4

In addition to weeds, a range of degrading influences was recorded as being prominent features of vegetation units. The most significant issue was the lack of delineation between lawn and vegetation. Grass invasion was regularly seen to be encroaching upon and smothering native species such as sedges, herbs and shrubs. This occurrence was not limited to expansive grassed areas adjacent to remnant vegetation, as it often featured within sites of revegetation. The problem could regularly have been avoided if existing pathways were used as effective control barriers between grassed recreational areas and vegetated shorelines. Where the grass was maintained by slashing, this limited the growth of sedge vegetation in particular and posed a potential risk of further degradation to the sedges without adequate delineation for management of grasses in place (Table 2.6).

The second most prevalent issue was the practice of maintaining mowed grass beneath established native trees without any provision for natural regeneration. This is of greatest concern along the estuary, given the limited remaining native overstorey. The eventual loss of mature established trees due to natural attrition represents a future deficit in the absence of natural regeneration.

Understorey trampling, domestic animal grazing and disturbance around plant roots were also regularly recorded as impacting on vegetation. Without adequate management, these factors will lead to the further deterioration of foreshore vegetation.

Table 2.6 Five major management pressures across the Swan and Canning rivers

System	Area (ha)	% Area
No delineation between lawn and vegetation	1681	63.9
Mowed grass beneath established trees	790	30.0
Trampled understorey	258	9.8
Evidence of domestic animal grazing	243	9.2
Disturbance around plant roots	176	6.7

2.3 Strategies for Management

Management strategies have been developed for each issue in relation to the wider objectives of the study (Table 2.7 and Table 2.8). The zones of the river that are relevant to each strategy are presented below. More detailed spatial coverage is shown in Table 4.3 and Table 4.7.

Table 2.7 Management strategies to protect and enhance the riverbanks and shorelines (Zone 1 - Estuary; Zone 2 - Swan; Zone 3 - Canning)

Objective 1: To protect and enhance the riverbanks and shorelines to mitigate threats to foreshore values		
Issue	**Management Strategy**	**Zones**
Inadequate foreshore setback	**A:** Managed migration. Where appropriate, allow natural erosion processes to occur (i.e.: outside meander bends and mobile sedimentary shores). This may require removal of some infrastructure and restricting public access.	1,2,3
	B: Ensure future developments have sufficient foreshore setback to allow for inundation and channel planform / bank migration.	1,2,3
	C: Address potential for increased flooding and inundation in prone areas.	1,2
	D: Undertake renourishment where appropriate.	1,2,3
	E: Where valuable infrastructure or recreational amenity is threatened by erosion and renourishment is not an option, consider appropriate stabilisation works, including bioengineering.	1,2,3
Inadequate natural stability	**F:** Prepare a foreshore revegetation plan to widen vegetation buffer. Use bioengineering where appropriate. Ensure foreshore is stabilised when weeds are removed.	2,3
	G: Manage recreation use areas by providing controlled pedestrian access, fishing platforms and minimise impact of boat launching and landing control.	1,2,3
	H: Fencing to minimise animal trampling with management of introduced animal pests.	2,3
Disturbance of sediment transport patterns	**I:** Investigate measures to reduce sedimentation, including increased river flow through dam release, review of private abstraction licences to ensure sufficient environmental flows, sediment extraction or removal of artificial barriers to flow.	3
	J: Reduce sediment input through a comprehensive sediment management plan.	2,3
	K: Improve control of boating, including enforcement of low speed zones and establish low or no wash zones. Continue community awareness and education projects about boat wash.	2
	L: Encourage retrofitting of existing drainage structures to incorporate sediment traps and design features to minimise scour. Promote stormwater management plan.	1,2,3
Inadequate structural stability	**M:** Develop plan for monitoring and maintenance of structures, including structures which are no longer functional and could be removed.	1,2,3
	N: Identify mechanisms for sourcing funds (including River*bank*) to support maintenance works.	1,2,3

Table 2.8 Management strategies to protect, enhance and manage fringing indigenous vegetation and habitat (Zone 1 - Estuary; Zone 2 - Swan; Zone 3 - Canning)

Objective 2: To protect, enhance and manage fringing indigenous vegetation and habitat		
Issue	**Management Strategy**	**Zones**
Loss of connectivity	**O:** Improve linkage between regionally significant and good quality vegetation areas (including lateral connectivity to floodplain and wetlands) through planning and action.	1, 2, 3
	P: Address localised breaches in fringing sedge vegetation.	1, 2, 3
Loss of complexity	**Q:** Improve the structural integrity of vegetation in regionally significant areas.	1, 2, 3
	R: Increase the vegetative buffer width and structural complexity of foreshores where susceptible to erosion.	1, 2, 3
	S: Where appropriate, establish no mow zones under remnant overstorey to allow for regeneration.	1, 2, 3
	T: Support tree replacement programs, awareness raising and actively discourage tree vandalism.	1, 2, 3
Invasive species	**U:** Target highly invasive weeds species through coordinated / cross boundary effort.	1, 2, 3
	V: Ensure Best Management Practice in weed control and rehabilitation work.	1, 2, 3
	W: Support removal of exotic grasses and replacement with local native species between the river and riverside pathways, allowing for designated grassed recreation areas in the vicinity of recreational infrastructure.	1, 2, 3
Degradation of regionally significant vegetation	**X:** Encourage development of foreshore management plans for all significant areas, to include controlled foreshore access, management of degrading influences, integrated weed management and management of recreation nodes.	1, 2, 3
	Y: Increase profile of regionally significant sites and raise foreshore user awareness of values and degrading behaviours through development of interpretive trails / signage and information resources etc.	1, 2, 3
	Z: Promote the establishment of no or low wash zones around ecologically sensitive areas.	3
Effectiveness of effort / coordination	**AA:** Monitor condition and effectiveness of rehabilitation activity, trial innovative techniques for addressing degradation and provide extension role to land managers.	1, 2, 3
	AB: Trial approaches to improve revegetation success and weed control.	1, 2, 3
	AC: Support community and private effort in rehabilitation and awareness raising activities.	1, 2, 3

2.4 Management Priorities

There are large areas of foreshore that are in need of management. In order to focus action in key areas, a system of prioritisation was undertaken (see sections 4.3 – Riverbanks and Shorelines; and 4.5 Vegetation). Table 2.9 shows area based priorities for management that have been identified and grouped into broader management areas based on land management boundaries and the similarity of management response.

Table 2.9 Management priorities within each zone

Zone	Management Area	Riverbanks and Shorelines Priority	Vegetation Priority
Estuary Foreshore (Zone 1)	1. Fremantle traffic bridge to Rocky Bay, North Fremantle (western foreshore)	**Priority 2** S.1 Lower Fremantle to Chidley Point	**Priority 3** V.10 Gilbert Fraser Reserve, North Fremantle V.11 Rocky Bay, North Fremantle
	2. Rocky Bay to JH Abrahams Reserve, Subiaco	**Priority 2** S.1 Upper Fremantle to Chidley Point S.5 Point Resolution to Nedlands Foreshore S.6 Nedlands foreshore to Pelican Point (minus Pelican Point section) Priority 3 S.2 Chidley Point to Keanes Point S.3 Keanes Point to Claremont S.4 Claremont Cliffs to Point Resolution	**Priority 2** V.5 Point Resolution Reserve, Dalkeith (Bush Forever site) V.6 Chidley Point and adjacent bushland, Mosman Park (Bush Forever site) V.7 Minim Cove, Mosman Park (Bush Forever site) V.9 Peppermint Grove foreshore (Bush Forever site)
	3. Pelican Point and Matilda Bay	**Priority 2** S.6 Nedlands foreshore to Pelican Point (minus Nedlands foreshore section) Priority 3 S.7 Pelican Point to UWA Boat Club (Matilda Bay)	**Priority 2** V.4 Pelican Point Crawley (Bush Forever site)
	4. Mounts Bay Road and Riverside Drive foreshores	**Priority 1** S.8 UWA Boat Club to Narrows S.9 Narrows to Barrack Square S.10 Barrack Square to Point Fraser	**Low Priority**
	5. Fremantle traffic bridge to the end of Blackwall Reach Parade (eastern foreshore)	**Priority 2** S.1 Fremantle to Chidley Point	**Low Priority**
	6. Point Walter and Alfred Cove	**Priority 1** S.11 Point Walter Reserve (end of Blackwall Reach Parade to Stock Road) Priority 2 S.14 South Lucky Bay (Cunningham Street) to Point Dundas (limited to section directly abutting the Swan Estuary Marine Reserve) Priority 3 S.12 Point Walter to Alfred Cove S.13 Alfred Cove to South Lucky Bay (Cunningham Street)	**Priority 1** V.1 Blackwall Reach, Point Walter, Alfred Cove and adjacent bushland, Bicton to Applecross (Bush Forever site)

	7. Melville Beach Road to Bull Creek	**Priority 2** S.14 South Lucky Bay (Cunningham Street) to Point Dundas (section directly outside the Swan Estuary Marine Reserve) S.16 Applecross Jetty to Point Heathcote S.18 Coffee Point to Canning Bridge S.19 Canning Bridge to Mount Henry Bridge Priority 3 S.15 Point Dundas to Applecross Jetty S.17 Point Heathcote to Coffee Point	**Priority 2** V.8 Point Heathcote foreshore, Applecross (Bush Forever site) V.12 Canning Beach Road, Applecross
	8. McCallum Park and Sir James Mitchell Park	**Priority 1** S.22 Richardson Street to north end of PWC area (upper section) Priority 2 S.23 North end of Narrows PWC area to Mends Street S.24 Mends Street to Causeway	**Low Priority**
	9. Milyu Nature Reserve to Cloisters	**Priority 1** S.21 Como foreshore S.22 Richardson Street to north end of PWC area (lower section) Priority 2 S.20 Mount Henry Bridge to Canning Bridge (upper section)	**Priority 1** V.3 Milyu Nature Reserve, South Perth
Swan River (Zone 2) Includes the lower Avon River and Helena River	10. Point Fraser and Burswood Park to Clarkson Reserve and Adachi Park	**Priority 1** S.30 Balbuck Way Water Ski Area (west bank, formerly Goodwood Parade) Priority 2 S.26 Causeway to Claisebrook S.28 East Perth Power Station and Banks Reserve S.32 Cracknell Park to Ascot Waters entrance channel Priority 3 S.25 Heirisson Island S.27 Causeway to Windan Bridge S.29 Bardon Park S.31 Maylands Peninsula - golf course to Clarkson Reserve	**Priority 2** V.16 Swan River Foreshore, Mount Lawley / Maylands (Bush Forever site) V.23 Burswood Island Priority 3 sites: V.24 Brighton Road, Rivervale V.25 Peninsula Golf Course foreshore, Maylands V.26 Charles Preston Park, Burswood
	11. Tranby foreshore and Ascot to Ashfield Parade and Garvey Park	**Priority 1** S.34 Tranby on Swan (including Bath Street Reserve) S.35 Ascot Racecourse S.36 Claughton Reserve (Katanning Street Boat Ramp) (lower section) Priority 2 S.33 Hardey Road Reserve	**Priority 1** V.15 Swan River saltmarshes, Bayswater / Maylands (Bush Forever site) Priority 3 sites: V.27 Ellis House, Bayswater V.28 Bayswater Riverside Gardens, Bayswater V.29 The Riverwalk, Ascot

	12. Ashfield Parade and Garvey Park to Success Hill and Fish Market Reserve, including Helena River to East Street	**Priority 1** S.36 Claughton Reserve (Katanning Street Boat Ramp) (upper section) S.37 Ashfield Parade / Ron Courtney Island / Garvey Park Priority 2 S.39 Sandy Beach Reserve to Helena River confluence (both banks) S.38 Sandy Beach Reserve Priority 3 S.40 Helena / Swan confluence (including Point Reserve) S.41 Lower Helena	**Priority 2** V.18 Swan River Backwater, South Guildford (Bush Forever site) V.20 Ashfield Flats, Bassendean / Ashfield (Bush Forever site) V.22 Southwest of Garvey Park, Ascot
	13. Success Hill Reserve to Walyunga National Park	**Priority 1** S.43 Success Hill S.46 S.47 Priority 2 S.42 Fish Market Reserve S.45 St Vincent's Hospital foreshore to Woodbridge Riverside Park (including St Charles Seminary) S.48 John George Walk Trail (Blackadder Creek to Reg Bond Reserve) S.50 Middle Swan Bridge Reserve S.54 Bells Rapids Park to Bells Rapids Priority 3 S.44 St Vincent's Hospital foreshore S.49 Midland Brick foreshore (private) S.51 Middle Swan Bridge Reserve to Susannah Brook confluence S.52 Ellen Brook confluence and All Saints Church S.53 Upper Swan Bridge and Pullman Park	**Priority 1** V.13 Bennett Brook, Eden Hill to West Swan (Bush Forever site) V.14 Swan River and Jane Brook, Ashfield to Upper Swan (Bush Forever site)
	14. Walyunga National Park to Moondyne Brook	**Low Priority**	**Priority 2** V.19 Walyunga National Park V.21 Avon Valley National Park
	15. Helena River from East Street to the lower Pipehead Dam	**Low Priority**	**Priority 3** Except for: V.17 Helena Valley (Bush Forever site) is of **Priority 2** status
Canning River (Zone 3) Includes Southern River	16. Cloisters to Clontarf Bay	**Priority 3** S.20 Mount Henry Bridge to Canning Bridge (lower section) Priority 2 S.56 Salter Point S.55 Mount Henry and Aquinas Bay Priority 3 S.57 Salter Point West (Salter Point to Curtin University Rowing Club) S.58 Clontarf to Shelley Bridge	**Priority 1** V.2 Mount Henry bushland, Salter Point (Bush Forever site) V.30. Canning River foreshore, Salter Point to Wilson / Clontarf (Bush Forever site)

	17. Bull Creek and Shelley-Rossmoyne foreshores to Riverton Bridge	**Priority 1** S.59 Leach Highway off-ramp (Centenary Avenue) Priority 2 S.60 Bull Creek S.61 Shelley-Rossmoyne foreshore (Bull Creek to Shelley Bridge) S.62 Shelley Bridge to Riverton Bridge (both banks)	**Priority 2** V.34 Yagan Wetland and adjacent Bushland from Rossmoyne to Bull Creek (Bush Forever site) Priority 3 V.36 Shelley-Rossmoyne foreshore, Tuscan Street, Rossmoyne V.37 Shelley-Rossmoyne foreshore, west of Shelley Bridge, Shelley
	18. Canning River Regional Park	**Priority 1** S.63 Kent Street Weir Priority 3 S.64 Masons Landing Park	**Priority 1** V.31 Canning River Regional Park (Bush Forever site)
	19. Nicholson Road Bridge to Fancote Park (Canning River) and Margaret Street (Southern River)	**Priority 1** S.67 Bickley Brook to scarp on Southern and Canning rivers Priority 2 S.66 Djarlgarra Bridge (Roe Hwy) to O'Dell Street Priority 3 S.65 Hester Park S.68 Ferres Drive Bridge	**Priority 1** V.33 Canning and Southern rivers (Bush Forever site)
	20. Fancote Park to Stinton Creek	**Priority 1** S.67 Bickley Brook to scarp on Southern and Canning rivers (upper reaches)	**Priority 2** V.35 Collins Road, Roleystone Priority 3 site: V.38 Croyden Road, Roleystone
	21. Margaret Street (Southern River) to Allen Road Crossing	**Priority 1** S.67 Bickley Brook to scarp on Southern and Canning rivers (upper reaches)	**Priority 2** V.32 Dallen Road bushland, Southern River, Gosnells (Bush Forever site)

3 Foreshore Assessment

3.1 Overall Approach

The Foreshore Assessment was aimed at describing the Swan and Canning rivers foreshores, their pressures and condition. In doing so, the foreshore of this large system was divided into three zones, and elements of the shoreline (both built and non-built) and vegetation were considered in each of these zones (Figure 2.1). The zones include:

1. **Estuary:** Perth and Melville waters downstream of the Causeway and Mount Henry Bridges (Zone 1);
2. **Swan:** Swan, Helena and Lower Avon rivers upstream of the Causeway and within the Swan River Trust Management Area (Zone 2); and
3. **Canning:** Canning and Southern rivers upstream of Mount Henry Bridge within the Swan River Trust Management Area (Zone 3).

Twenty-one Local Government Authorities (LGAs) have boundaries adjacent to, or including, the study area. The area and linear length of foreshore within each local government area is shown relative to each river zone in Appendix 1.

Within each zone, foreshore processes and character were assessed, together with vegetation type and condition.

3.2 Riverbank and Shoreline Assessment

3.2.1 Assessment method

'Shoreline' is defined as the area two metres either side of the high water mark (*Swan Canning Rivers Management Act 2006*). This is used in combination with the term 'riverbank' to acknowledge the spatial extent of foreshores and their values.

The three principal components of the riverbank and shoreline assessment included:

1. Physical description
   The present state of the riverbanks and shorelines, along with evidence of active geomorphic processes and management actions, were documented.
2. Assess condition and function of built structures
   The condition and function of the foreshore retaining structures and drains was assessed in the field according to Damara (2007; Table 3.1a). The drainage information also included drainage type, associated impacts and any design features used to minimise impacts on the foreshore. Recommendations for works were recorded for each structure.
3. Potential for changes
   Comments were made on the potential for change to the foreshore, based on the foreshore state and a conceptual understanding of foreshore stability and prevailing processes.

Table 3.1a Description of condition for built structures

Assessment	Condition	Function
Good	The structure is well maintained and is not subject to damage from active processes.	No evidence of material loss from behind the structure. The structure performs its function under the full range of conditions experienced since construction or last major maintenance.
Fair	The structure has experienced some damage due to active processes. In general, this damage is minor and any repair would be considered routine maintenance.	Good retention under moderate conditions, with some material loss during extreme or infrequent events. Minor loss of material affects less than 25 per cent of the area immediately behind the structure.
Poor	Damage has occurred to the structure. The structure would require replacement, possibly with design modifications, to accommodate the active processes.	The structure is performing unsatisfactorily as a retaining system. Significant sediment loss affects more than 25 per cent of the area immediately behind the structure.

3.2.2 Riverbanks and shoreline overview

3.2.2.1 Pressures and problems

Rivers and estuaries are constantly adjusting their form in response to natural geomorphic processes, shifts in natural conditions in the surrounding catchment and from human impacts. The foreshore is a dynamic boundary that responds to relative movements of both land and water. The dynamic nature of foreshore migration and inundation is only a concern when there is something of value immediately adjacent that is threatened by erosion or inundation. As human activities and infrastructure are generally in the 'dry' part of the profile, landward movement of the foreshore typically has the most significant impact on human amenity. Offshore movement of the foreshore (e.g. accretion) generally has a more limited effect on amenity for the majority of foreshore activities. However, accretion may affect navigation, and smothering of riparian vegetation or benthic habitats. Sedimentation of riverine reaches can also affect navigation and results in increased channel migration and inundation.

A range of external forcing, including erosion and inundation processes, operates on the foreshores of the Swan Canning system. The type and magnitude of the governing processes operating on a foreshore of certain characteristics (e.g. vegetation coverage, foreshore elevation) can result in net erosion or accretion of the foreshore, inundation of the foreshore or sedimentation of the channel. Foreshore instability is a concern for management when it threatens something of value.

Foreshore erosion

A range of erosion mechanisms may be active including:

- Energetic Wave Conditions: often associated with quite dramatic loss on beaches during single storm events;
- Increase in Mean Water Level: causes an upwards migration of the active hydraulic zone;
- Decrease in Mean Water Level: lowered water levels cause a downwards migration of the active hydraulic zone;
- Vegetation Loss: loss of vegetation tends to provide a bank that is less resistant to hydraulic action;
- Sediment Sink / Sources: locations where there is an imbalance of sediment transport experience net erosion or accretion;
- Sediment Deficit: change that alters the prevailing sediment transport conditions, removing a quantity of sediment from active forcing before normal transport patterns return;
- Strong Currents: located principally where there are restrictions in cross-sectional area;

- Seasonality: both the intensity of prevailing conditions and their persistence may affect the net sediment transport rate;
- Drainage Structures: erosion associated with drainage outfalls may extend beyond the immediate vicinity of the flow path;
- Flow over Banks: erosion, often in the form of gully erosion, associated with water flowing directly over the banks due to drainage of overtopped water or as a result of stormwater runoff; and
- Sedimentation: sedimentation of the channel decreases the channel cross-sectional area and thereby increases the potential for channel planform migration and inundation as a result of flooding.

Foreshore erosion is generally associated with energetic conditions. However, low-energy conditions may also occasional create foreshore retreat.

Inundation

Inundation of the foreshore occurs when water levels and waves are high enough to cause flooding of normally dry land. This can impact on foreshore vegetation or structures and curtails amenity. In the estuarine reaches, the inundation level is largely determined by the summation of tides, surges and wave excursion over land. Wave action is strongly influenced by the profile grade and the permeability of the surface over which waves run up. In the riverine reaches, the inundation level is dependent on topography and flood levels.

For estuarine beaches in the Swan River, formation of a seasonal tidal berm typically occurs around +0.5 m AHD. This is usually below the annual maximum water levels, and consequently, under high water-level events, waves will tend to wash over the beach, percolating through the sand and dissipating the wave energy.

Although engineered mitigation structures (e.g. walls and gabions) are generally higher than beaches, they have low permeability, which allows waves to run up further. Drainage of the overtopping water places considerable stress on the protective structures. For areas of flat land behind the walling, such as Nedlands foreshore, waves may travel relatively long distances before dissipating.

Within the estuarine reaches, inundation effects vary significantly, depending upon the degree of wave exposure and the joint probability of surge and wave directions. Generally, west-facing shores experience the greatest inundation, as westerlies are associated with positive oceanic surge and are most severe during winter, when mean water levels are high.

Inundation of the banks in the upper reaches of the Swan and Canning results in increased activity of the floodplain. Although inundation by flooding can be detrimental to infrastructure, the over-bank processes are beneficial as sediment deposition in some areas can result in the regeneration of banks. Many of the floodplains contain secondary channels or gullies to drain the floodwaters back into the channel. The low-lying regions where rivers and brooks converge are the most susceptible to inundation by floodwaters.

Foreshore stability

Problems related to foreshore stability can be grouped into four broad categories:

1. Inadequate foreshore setback: when development occurs too close to the river in areas where the bank is highly susceptible to external loads such as river flow or inundation;
2. Inadequate natural stability: when bank structure is reliant on small internal features, particularly those susceptible to change, such as a bank maintained by tree roots;
3. Disturbance of sediment transport patterns: susceptibility to external changes in sediment transport and sediment supply; and

4. Inadequate structural stability: the performance of engineered structures (type, condition and function) to ensure ongoing foreshore stability. This is anticipated to be a less significant problem in the Swan and Canning than in the estuary as there is a smaller area of reclaimed foreshores.

Foreshore instability is generally only a concern when the instability threatens infrastructure, recreational amenity, public safety, and environmental or economic values.

3.2.2.2 Shoreline type

Non-built shorelines

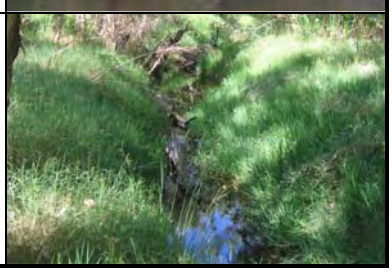
Non-built foreshores are those without engineered erosion protection systems and may include some artificially formed shores, such as Como and Attadale foreshores. Non-built shores may be further classified into rocky, vegetated or sedimentary shores, and each of these shore types has differing degrees of sensitivity to change (Table 3.1).

- **Rocky foreshores** are resistant to change and generally require minimal ongoing management.
- **Vegetated foreshores** are partially resistant to change as the roots act to form a matrix that holds sediment in place. The presence of vegetation reduces the responsiveness of the shore to low level hydraulic stresses (Biedenharn *et al.* 1997). Wave heights of less than 0.3 m can typically be tolerated by vegetation without causing damage. Wave heights exceeding 0.5 m actively destabilise the vegetation and only broad strips of riparian vegetation can withstand these conditions for sustained periods (Shafer *et al.* 2003). These findings, although not derived for Australian plant species, appear to be consistent with the presence of vegetation in the study region. However, the protection afforded by vegetation may be disrupted by a range of events, including human activities, extended inundation or exposure, undercutting, or by wave events exceeding the structural capacity of the vegetation. In many situations, such destabilisation may not threaten the foreshore stability. However, where the structure of the foreshore relies upon the presence of vegetation, the relative risk of destabilisation is greater.
- **Sedimentary foreshores** are dynamic, responding to the changing hydrodynamic conditions through ongoing profile and plan form adjustment. The spatial and temporal scale of the adjustment depends upon the amplitude of the loads and the mobility of the foreshore material.

Built shorelines

Built structures are defined as hard-engineering approaches to shore stabilisation that reduce the response of the foreshore to variations in environmental conditions.

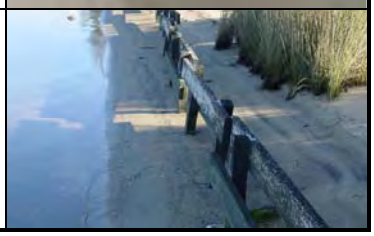
Table 3.1 Shoreline types

Type	Sub-type	Example Photograph
Built structure	Artificial shore of one of three sub-types: 1. Groyne Field–shore controlled by a groyne or groyne field; 2. Revetment–inclined foreshore structure (<60°); and 3. Walled–steep foreshore structure (>60°). Usually constructed from concrete, steel, rock or timber.	
Rock shore	Natural shore dominated by rock, with two sub-types: 1. Rocky (Emergent)–submerged reefs, planar shore platforms, emergent rock features and rock shores in pool / riffle systems; and 2. Cliff–steeply graded (>60°) rock foreshore with elevation above 1.5 m.	
Sedimentary	An exposed shore largely comprised of mobile sediments in one of three sub-types: 1. Beach–dominated by moderate to high wave action; 2. Perched Beach–beach partly held in place by submerged rock platform or reef; and 3. Embankment–subject to low wave action, dominated by river flows.	
	4. Exposed bank–shore of relatively cohesive sediments. Bank often has a vertical face or incised scour.	
	5. Scarp–steeply graded (>45°) exposed, relatively unconsolidated sediment, elevation above 1 m.	
Vegetated	1. Sedge–shore with riparian vegetation dominated by sedges. This classification also covers wetland environments that are regularly inundated.	
	2. Tree-lined–shore maintained by riparian trees.	
	3. Grass / weeds–shore dominated by grass / weed coverage.	

3.2.2.3 Built structure type

Five types of built structures can be distinguished in the Swan Canning system (Table 3.2). The presence of structures documents the areas of historic priorities for foreshore management. Engineered riverbanks rely upon the structural adequacy of the foreshore protection system that has been installed. A structure is generally not required if there is no infrastructure or recreational value within the immediate vicinity of the foreshore that requires mitigation from erosive processes.

Table 3.2 Shore retention structure types

Type	Description	Example
Wall	Steep foreshore structure (>60°). Usually constructed from concrete, steel, rock or timber. Includes: 1. Sheet piling; 2. Concrete panels; 3. Limestone blocks; 4. Rubble walls; and 5. Log and other timber walls.	
Revetment	Inclined foreshore structure (<60°). Usually constructed from rock. Material can be tipped, placed or cut to fit together.	
Gabions	Baskets filled with rock units. These porous cages can be constructed as a wall, revetment or toe protection. Often placed in conjunction with revegetation.	
Groynes	Shore-connected, and often shore-perpendicular, structures placed to reduce the quantity of alongshore sediment transport by partitioning the shoreline.	
Wave attenuation structures	The main structure used to provide wave attenuation in the Swan-Canning is wooden baffle boards.	

Many built structures in the Swan Canning system have been in place for long periods and now remain beyond their design life. Others are inappropriate for their location. In general, the 30 year Average Recurrence Interval (ARI) wave height should be considered as a design condition. The conditions under which different types of structure will generally perform adequately along the estuary foreshore are described in Table 3.3.

Table 3.3 Approximate wave capacity for different structure types

Type	H_s < 0.3 m	0.3 – 0.5 m	0.5 – 0.8 m	0.8 – 1.0 m	> 1.0 m
Log wall	Stable	Stable			
Limestone block wall	Stable	Stable	Stable		
Revetment	Stable	Stable	Stable	Stable	Stable
Concrete panel wall	Stable	Stable	Stable	Stable	
Gabions	Stable	Stable	Stable	Stable	Stable

3.2.3 Riverbanks and Shoreline Description

The present state of the foreshores, along with evidence of active geomorphic processes and management, are described below.

3.2.3.1 Estuary (Zone 1)

There were 63.2 km of foreshore in the estuary zone. The largest proportion of the shore types were sedimentary (45 per cent), followed by built structure (34 per cent). Approximately 10 per cent of the estuary foreshore is vegetated shoreline, lined with trees, sedges or other wetland plant species, with rocky shores were observed the least (8 per cent) (Table 3.4). The shore type 'variable' was used in the Estuary Zone to classify foreshores where the dominant shore type could not be distinguished within a reach.

Table 3.4 Shore types along the Estuary Zone

Shore types	Length (km)	% of Zone
Built structure	21.8	34%
Rocky	5.1	8%
Sedimentary	**28.5**	**45%**
Vegetated	5.7	9%
Variable (estuary only)	2.5	4%
Total	63.2	100%

The relative importance of sediment transport mechanisms along the estuary foreshores was interpreted on the basis of existing infrastructure and management (Appendix 5). The prevailing sediment transport mechanism in the Estuary Zone is wave-induced sediment suspension and longshore transport, including seasonal variability.

Foreshore areas along the lower estuary which are likely to exhibit ongoing erosion and accretion are listed Table 3.5.

Table 3.5 Wave-driven erosion and accretion zones

Erosion Zones	Shore Type	Accretion Zones	Shore Type
Claremont	Rocky	Chidley Point	Sandy lobe
Nedlands	Reclaimed, Walled	Point Resolution	Sandy lobe
Mounts Bay Road	Reclaimed, Walled	J H Abrahams	Sub-tidal flat
Barrack Square	Reclaimed, Mixed	Matilda Bay N	Sub-tidal flat
James Mitchell	Reclaimed, Walled	Narrows	Linear sand bar
Como Beach	Reclaimed, Sandy	Causeway	Sand bars
Waylen Bay	Sandy	Canning Bridge	Sandy lobe
Lucky Bay	Walled	Point Dundas	Rocky
Point Walter	Sandy	Alfred Cove	Sub-tidal flat

Several foreshore areas are susceptible to inundation (Table 3.6). The southern Como foreshore is particularly vulnerable as it is subject to both coastal flooding and severe wave events and is occupied by one of Perth's main arterial thoroughfares (Kwinana Freeway).

Table 3.6 Areas susceptible to inundation

Area	Infrastructure
Como Beach S	Kwinana Freeway
Point Heathcote E	Dual use path (no buildings)
Claremont Foreshore	Claremont Yacht Club
Como Scout Hall	Sea Scout Hall
Como Beach N	Kwinana Freeway
Melville Parade	Kwinana Freeway
James Mitchell W	Boatshed Café
Claremont Colleges	Boat sheds
Point Resolution	Private lots (not affecting buildings)
Mounts Bay Road	Mounts Bay Road; Swan Brewery
Perth Esplanade	Esplanade Road; Barrack Square
Nedlands Foreshore	Yacht clubs; Tawarri Lodge

3.2.3.2 Swan (Zone 2)

A total of 139 km of foreshore was assessed along the Swan Zone, and the largest proportion of foreshores were vegetated (36 per cent), followed by rocky (33 per cent) (Table 3.7). The majority of the vegetated banks were tree-lined (39 per cent of 49.8 km), sedge (29 per cent) or mixed tree-lined and sedge (21 per cent) (Table 5B in Appendix 6).

Table 3.7 Shore types along the Swan foreshore

Shore types	Length (km)	% of Zone assessed
Built structure	10	7%
Rocky	46.3	33%
Sedimentary	11.1	8%
Vegetated	**49.8**	**36%**
Vegetated / sedimentary	21.6	16%
TOTAL	138.8	100%

The Swan foreshore was characterised by six geomorphic units (Table 3.8) that are influenced by different active processes as shown in Table 3.9.

Table 3.8 Six geomorphic units defined in the Swan

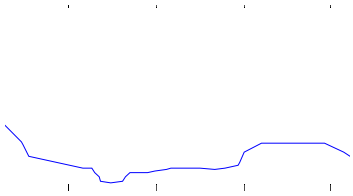
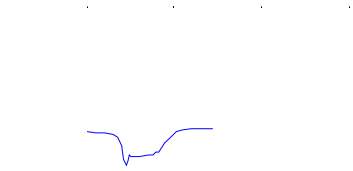
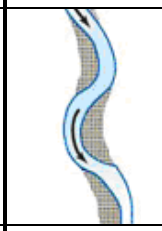
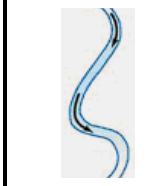
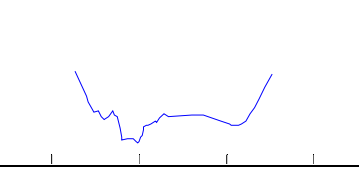
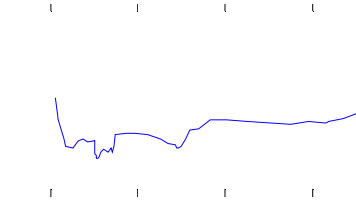
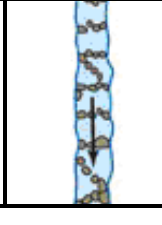
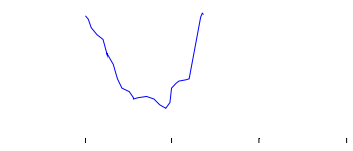
Geomorphic Unit	Spatial coverage
1	Swan River - Causeway to Helena River confluence.
2	Helena River - Upstream of Swan River confluence.
3	Swan River - Helena River confluence to Middle Swan Bridge.
4	Swan River - Middle Swan Bridge to Ellen Brook confluence.
5	Swan River - Ellen Brook confluence to base of Bells Rapids.
6	Swan / lower Avon Rivers - Upstream from base of Bells Rapids.

The Swan experiences more significant river flow than the Canning as the main tributary (the lower Avon River) and has no flow regulation structures. The region most susceptible to flooding is the Swan River between the Causeway and Bells Rapids. River flow reduces the bank stability on the outside of bends, on reclaimed foreshores, where the river width narrows and at confluence locations.

Sedimentation on the Swan River was evident immediately downstream of the scarp to Ellen Brook. As sediment continues to enter the Avon River, this region of sedimentation is likely to extend further downstream. Sedimentation is also anticipated to increase in magnitude across the regulated Helena River.

Table 3.9 Conceptual model of the six geomorphic units in the Swan

Note: The active processes are colour coded as follows: red = highly active; orange = moderately active; and yellow = minimally active.

Geomorphic Unit	Channel / Bank Characteristics				Active Processes					
	Channel pattern (from Church 2006)	Example cross-section	Downstream gradient	Sediment type	Flood risk	River flow[1]	Sedimentation	Non-fluvial water level	Wind waves	Boat wakes
1			Flat	Organics and sand						
2			Moderate	Silty-clays						
3			Flat	Organics and sand						
4			Flat	Sand-silt-clays and some rocky sands						
5			Moderate	Sand-silt-clays on banks with coarse bed						
6			Steep	Rock (riffle) and silt-sands						

The upstream influence of tidal (and surge) fluctuations is at the Ellen Brook confluence on the Swan River. Wind waves can be generated along south-westerly and easterly fetches of sufficient length along the Swan River downstream of the Helena River confluence. Boat wake impacts may be significant in regions where boating is permitted and river width is relatively narrow. The majority of bank erosion induced by boat wakes is evident between the downstream end of the Goodwood waterskiing area and Middle Swan Bridge. These reaches are shallow, narrow and have significant boat traffic.

3.2.3.3 Canning (Zone 3)

The Canning Zone includes 66 km of foreshore and the majority of shore types were vegetated (76 per cent), followed by mixed sedimentary / vegetated (18 per cent) (Table 3.10).

Table 3.10 Shore types along the Canning

Shore types	Length (km)	% of Zone assessed
Built structure	1.6	2%
Rocky	0.6	1%
Sedimentary	1.8	3%
Vegetated	**50.4**	**76%**
Vegetated / sedimentary	11.8	18%
Total	66.2	100%

The highest proportion of vegetated banks were tree-lined (36 per cent of 50.4 km) or tree-lined with grass / weeds (17 per cent) – only 20 per cent (10.2 km) of vegetated banks not characterised by trees (Table 5C in Appendix 6). Grass / weeds were a significant feature of bank stability for 16.8 km of the foreshores (Table 5C in Appendix 6).

The Canning shoreline was characterised by six geomorphic units (Table 3.11) and the active processes that influence the condition of those shoreline units are presented in Table 3.12.

Table 3.11 Six geomorphic units defined in the Canning

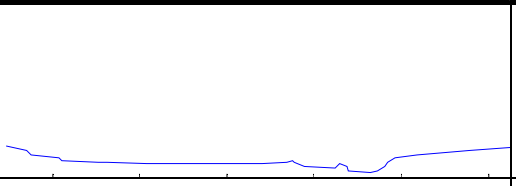
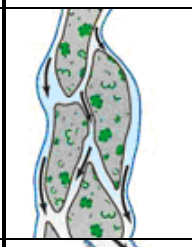
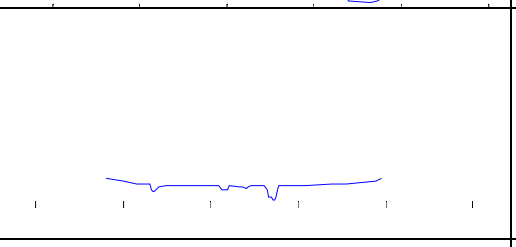
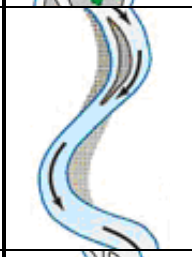
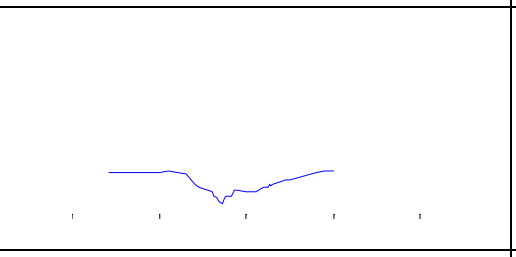
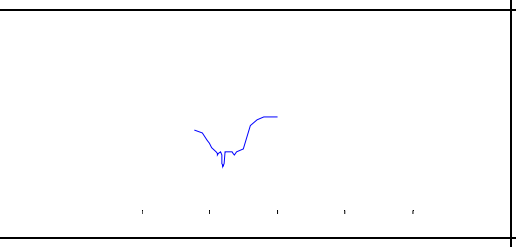
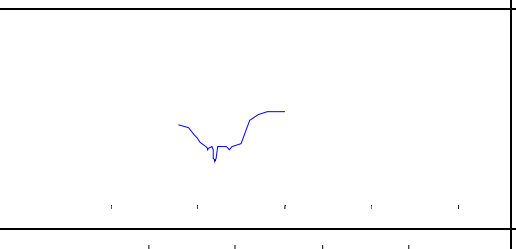
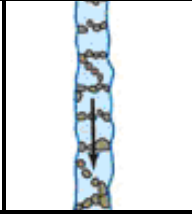
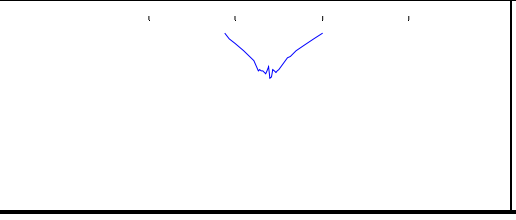
Geomorphic Unit	Spatial coverage
1	Canning River - Mount Henry Bridge to Riverton Bridge.
2	Canning River - Riverton Bridge to Kent Street Weir.
3	Canning River - Kent Street Weir to Southern River confluence.
4	Southern River - Upstream of Canning River confluence.
5	Canning River - Southern River confluence to base of scarp.
6	Canning River - Upstream of the scarp.

Flow regulation is the most significant cause of the extensive sedimentation occurring within the Canning. Flows within the Canning and Southern rivers have reduced 98 per cent and 92 per cent, respectively since the 19th century (Storey *et al.* 2002). In addition, many of the main tributaries, such as Bickley Brook, have been dammed. The dams reduce the volume of water flowing downstream and thereby alter sediment transport patterns. This has led to sedimentation within the rivers as there is insufficient flow to scour sediment from the bed (Units 3-6). The sedimentation can then result in increased flood levels, change to flow speeds and bank migration as the channel capacity is reduced.

River flows are active across the spatial coverage of the Canning, varying in significance both spatially and temporally. The influence of river flow in the Canning increases with distance downstream from the scarp (to Kent Street Weir) as additional water is supplied by tributaries and drains to the regulated baseflow.

Table 3.12 Conceptual model of the six geomorphic units in the Canning

Note: The active processes are colour coded as follows: red = highly active; orange = moderately active; and yellow = minimally active.

Geomorphic Unit	Channel / Bank Characteristics				Active Processes					
	Channel pattern (from Church 2006)	Example cross-section	Down-stream gradient	Sediment type	Flood risk	River flow[1]	Sedimentation	Non-fluvial water level	Wind waves	Boat wakes
1			Flat	Sand and muds / organics						
2			Flat	Silt-sands and organics						
3			Moderate	Sand and clay-silts						
4			Flat	Sand and clay-silts with fine-medium bed						
5			Moderate	Sand and clay-silts with fine-medium bed						
6			Steep	Rock / gravel (riffle) and silt-sands						

The upstream influence of tidal fluctuations stops at Kent Street Weir on the Canning River. Kent Street Weir results in a set-up of the water level behind the weir. This creates two vertical hydraulic zones above the weir, dependent on if the weir boards are in place. The seasonal hydraulic zones cause increased undercutting of the banks upstream of the weir. In addition, there are many mini-dams and crossings which modify the flow and generally result in increased bank erosion adjacent to the structure. On the Canning River, the open waters downstream of Nicholson Road Bridge can be subject to significant wind wave energy.

3.2.4 Condition of non-built foreshores

3.2.4.1 Estuary (Zone 1)

The largest proportion of the foreshore in the estuary can be classified as sedimentary (45 per cent).

Approximately 10 per cent of the estuary foreshore can be classified as vegetated shoreline and is lined with trees, sedges or other wetland plant species. The susceptibility of these reaches was evaluated by firstly considering the area for which waves above 0.5 m may occur under storm conditions, and secondly by identifying areas with high alongshore sediment transport rates or notable erosion characteristics. The influence of wave-forcing is reduced where the upper profile is relatively flat. Occasional wave damage may be experienced along approximately one-third of the vegetated shoreline of the estuary (Table 3.13). Scarping is present along all these high-energy sites, except for Shelley E, which has a very flat shore profile due to a stormwater outfall.

Table 3.13 Vegetated foreshores exposed to wave action above 0.5 m

Location	Wave Ht (3 yr)	Other Features	Susceptibility
Point Heathcote	1.4 m	Behind yacht club	Low
Como Beach N	1.3 m	High alongshore, eroding	High
Scout Hall	1.2 m	Flat profile	Moderate
Tompkins Park N	1.0 m	Scarped, accreting	Moderate
Alfred Cove E	0.8 m	Scarped	Moderate
Salter Point W	0.7 m	Partly scarped	Moderate
Rossmoyne W	0.7 m	High alongshore	Moderate
Shelley E	0.7 m	High alongshore	Moderate
Mount Henry W	0.6 m	High current	Moderate
Cloisters S	0.6 m	Erosion zone	Moderate
Shelley Water	0.6 m	Erosion zone	Moderate

The only vegetated foreshore which is exposed to a high risk of destabilisation is Como Beach N, where a high potential wave climate coincides with high alongshore sediment transport and ongoing erosion. Comparatively low risk conditions occur at Point Heathcote due to shelter from the South of Perth Yacht Club. Mount Henry W, Cloisters S and Shelley Water are natural zones of erosion that experience low wave energy. Rossmoyne W, Shelley E and Salter Point W experience minor damage due to pedestrian access.

Areas at risk from direct wave attack

Overall, the majority of beaches within the Estuary Zone are relatively unresponsive to energetic wave conditions, with only five locations determined to experience more than 10 m maximum erosion during a 30 year storm based on wind analysis and wind-wave hindcasting (Table 3.14). This reflects the relatively small difference between day to day and extreme wave conditions that occurs within a fetch limited environment.

Table 3.14 Locations affected by direct wave attack

Location	Projected Maximum Erosion	Infrastructure at Risk
Narrows (N) west of Barrack Sq	15 m	Roadway
Esplanade (S) Mount Pleasant	14 m	Dual Use Path
Mount Henry Bridge Reserve	13 m	None
Como Scout Hall	11 m	None
Lucky Bay (S) Applecross	11 m	Roadway

Areas at risk from oblique wave attack
Waves arriving obliquely to the shore produce alongshore sediment transport, which will create downdrift erosion behind any alongshore barrier. This behaviour is dramatically exhibited along Como foreshore and at boat ramps near Point Walter. Other locations where this occurs include Lucky Bay (Applecross), Attadale foreshore and Nedlands foreshore.

Areas affected by beach rotation and seasonal switching of sediment transport
Changes in prevailing wave direction (often seasonally) may either cause a change in the net sediment transport rate, or a reorientation of the shore structure. The latter may produce significant horizontal excursions of the shoreline. This is particularly true along extended stretches of foreshore and reaches with high alongshore sediment transport rates (Table 3.15).

Table 3.15 Reaches affected by beach rotation

Location	Length (km)	Rate of Transport
Como Beach	2.7	High
Lucky Bay (Applecross)	2.4	High
Matilda Bay	1.7	Low
Freshwater Bay	1.6	Low
Waylen Bay (Applecross)	0.8	High

Locations where there is a seasonal switch in the direction of alongshore sediment transport sometimes require careful foreshore management. Techniques intended to stabilise these areas act as traps when the direction of transport reverses, sometimes acting in opposition to their intended effect. An example of this problem is provided by the Mill Point western foreshore, where a sequence of short groynes has been constructed. These act to prevent any southward sediment transport, slowly resulting in erosion to the south of the groyne field.

Areas where a seasonal switch in sediment transport directions may occur include Attadale foreshore (towards Point Walter), Mounts Bay Road (near Matilda Bay) and Como foreshore (near Mill Point Road).

Areas identified as separation zones
The orientation of the shoreline and the distribution of waves across the estuary drives overall patterns of alongshore sediment transport. Differences in prevailing wave conditions or orientation of the shore may produce local differences in the direction of transport. A separation zone is a location from which the prevailing direction of sediment transport to either side of the site is in opposite directions. This creates a tendency for ongoing loss of sediment from the separation point. The majority of these separation points are located on reclaimed foreshore areas, in which case the erosion potential is at least partly mitigated by walling (Table 3.16). The most significant exceptions are at Como and Waylen Bay (Applecross), which have exhibited long-term erosion following extensive reclamation works in the 1950s and 1960s.

Table 3.16 Separation points within the estuary

Location	Comment
Claremont Cliffs	Rocky shore resist erosion
Nedlands foreshore	Walled reclamation, with slowly eroding bed
Mounts Bay Road	Walled reclamation, has experienced stress
Narrows Bridge (NE)	Stable until recent years
James Mitchell Park	Walled reclamation
Como Beach	Significant erosion
Waylen Bay	Significant reworking
Lucky Bay	Intermittent stress

Como foreshore has been the subject of a detailed analysis (Damara 2003; Eliot *et al.* 2006). Reclamation conducted in the 1950s for the Kwinana Freeway has shown a progressive pattern of erosion, resulting in the loss of the protective buffer to the road reserve. The original plans for regular renourishment have not occurred, with the exception of a single exercise several years after construction (Riggert 1978).

3.2.4.2 Swan (Zone 2)

More than two-thirds (69 per cent) of the Swan foreshore exhibits moderate to high erosion (Table 3.17; Figure 3.1, Figure 3.2). The presence of erosion on the upper bank is typically a result of significant flow events. The majority of the banks exhibited no scarping (64 per cent) with one- third of the banks showing evidence of low to moderate scarping (Table 3.18). Only 3 per cent of upper shores had high levels of erosion with scarping, with the majority occurring on the outside of meander bends.

Table 3.17 Longshore extent of bank erosion along the Swan

	Low (<33%)		Moderate (33–67%)		High (>67%)	
Zone	**km**	**% Zone**	**km**	**% Zone**	**km**	**% Zone**
Total Swan	43.6	31%	**53.5**	**39%**	41.5	30%

Table 3.18 Longshore extent of upper-shore scarping along the Swan

	None		Low (<33%)		Moderate |(33-67%)		High (>67%)	
Zone	**km**	**% Zone**	**km**	**% Zone**	**km**	**% Zone**	**km**	**% Zone**
Total Swan	**88.8**	**64%**	24.3	18%	21.0	15%	4.6	3%

The majority of banks within the Swan are influenced by the presence of trees. However, in many areas, there is only a single-line of trees; once this is lost there is increased potential for bank / channel planform migration. Foreshore stability in approximately 40 per cent of reaches on the Swan would be assisted by revegetation.

A total of 197 discharges were noted in the areas assessed in the Swan, with 140 drains, 38 drainage channels and 19 tributaries (Figure 3.3, Figure 3.4). The large percentage of drains with impacts on the foreshore (74 per cent) compared with the number of drains with erosion control features (47 per cent) suggests that further erosion control features could be considered for this Zone (Table 5I in Appendix 6).

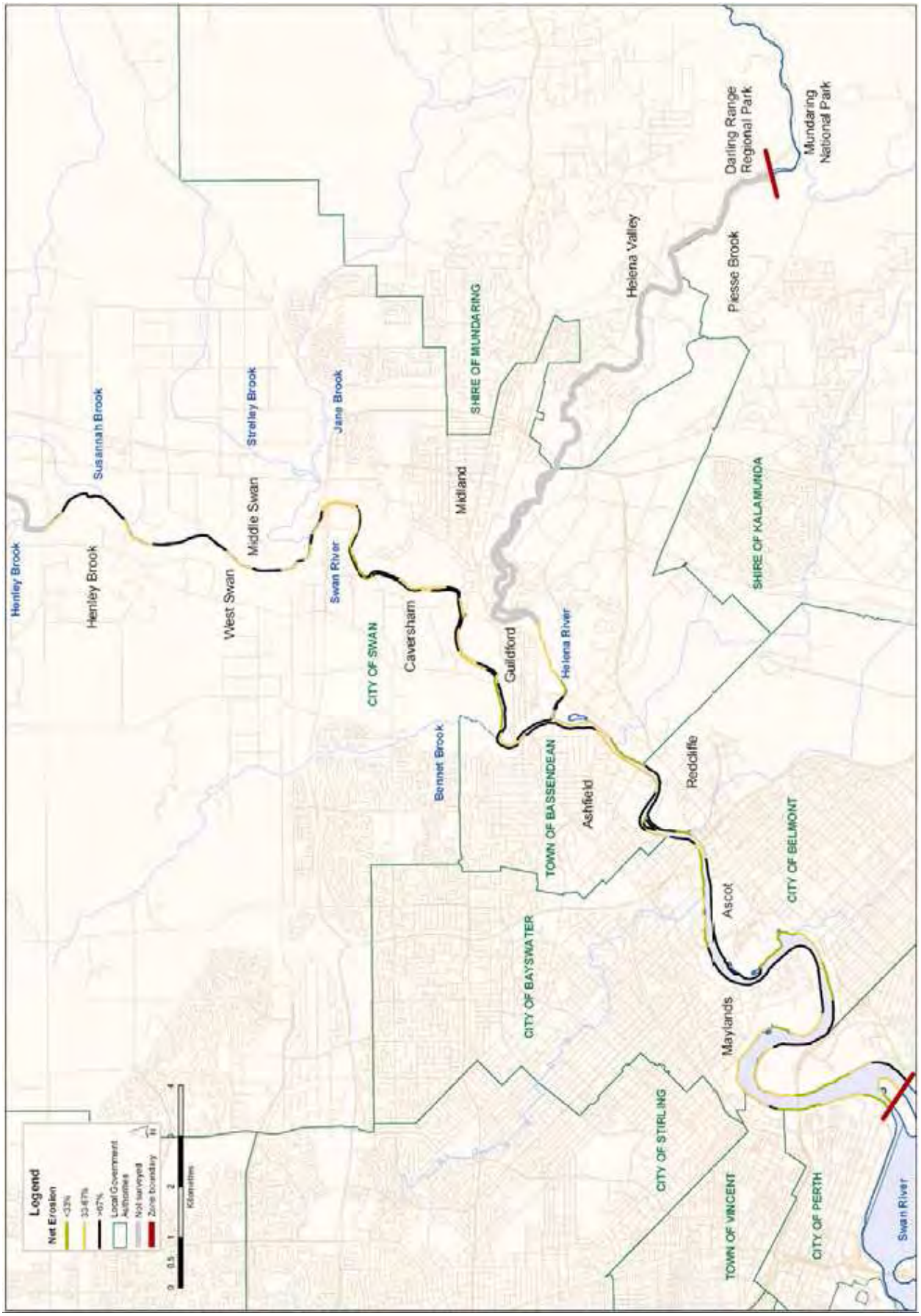


Figure 3.1 Extent of foreshore erosion along the lower Swan

Figure 3.2 Extent of foreshore erosion along the upper Swan

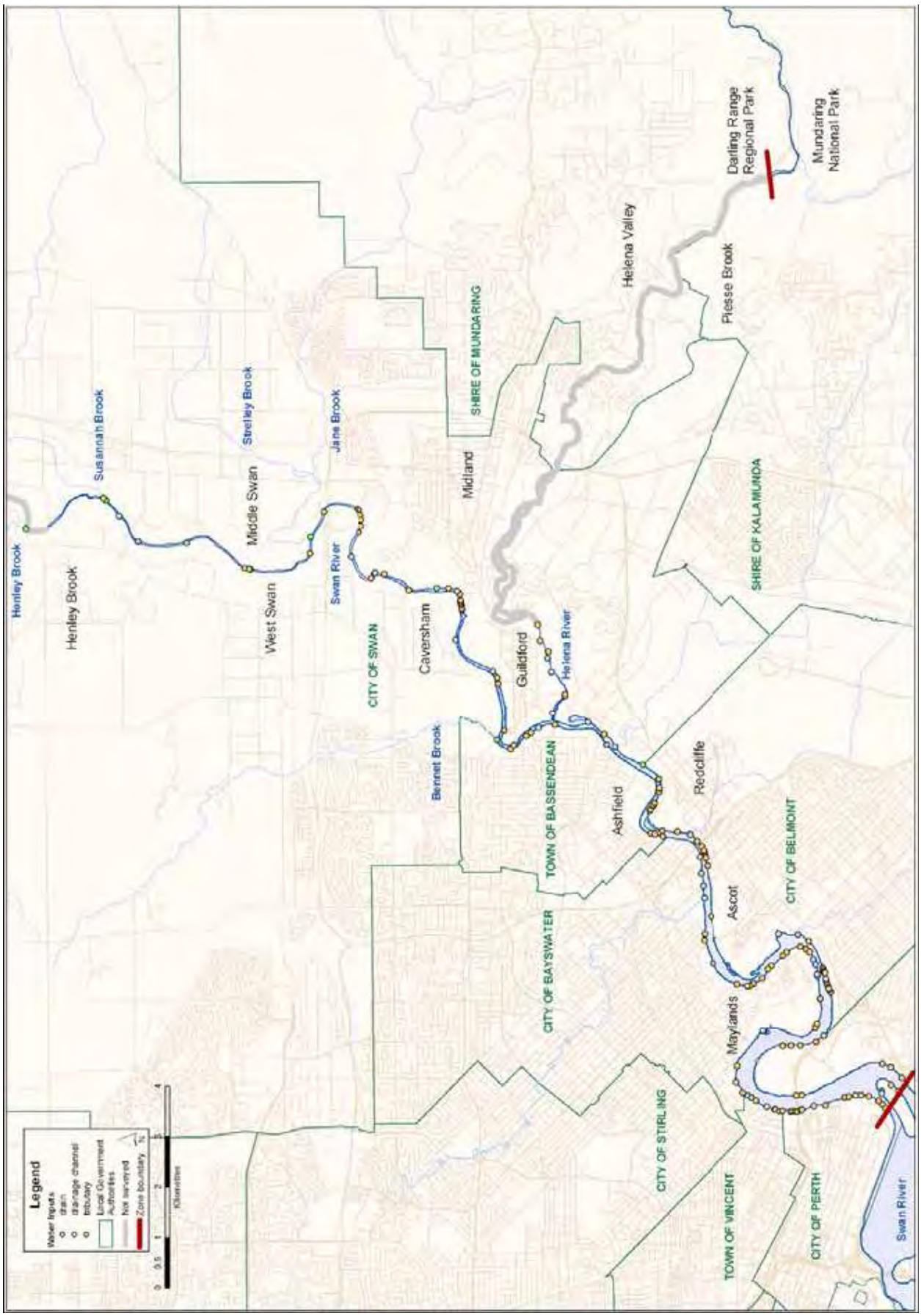


Figure 3.3 Discharge points along the lower Swan

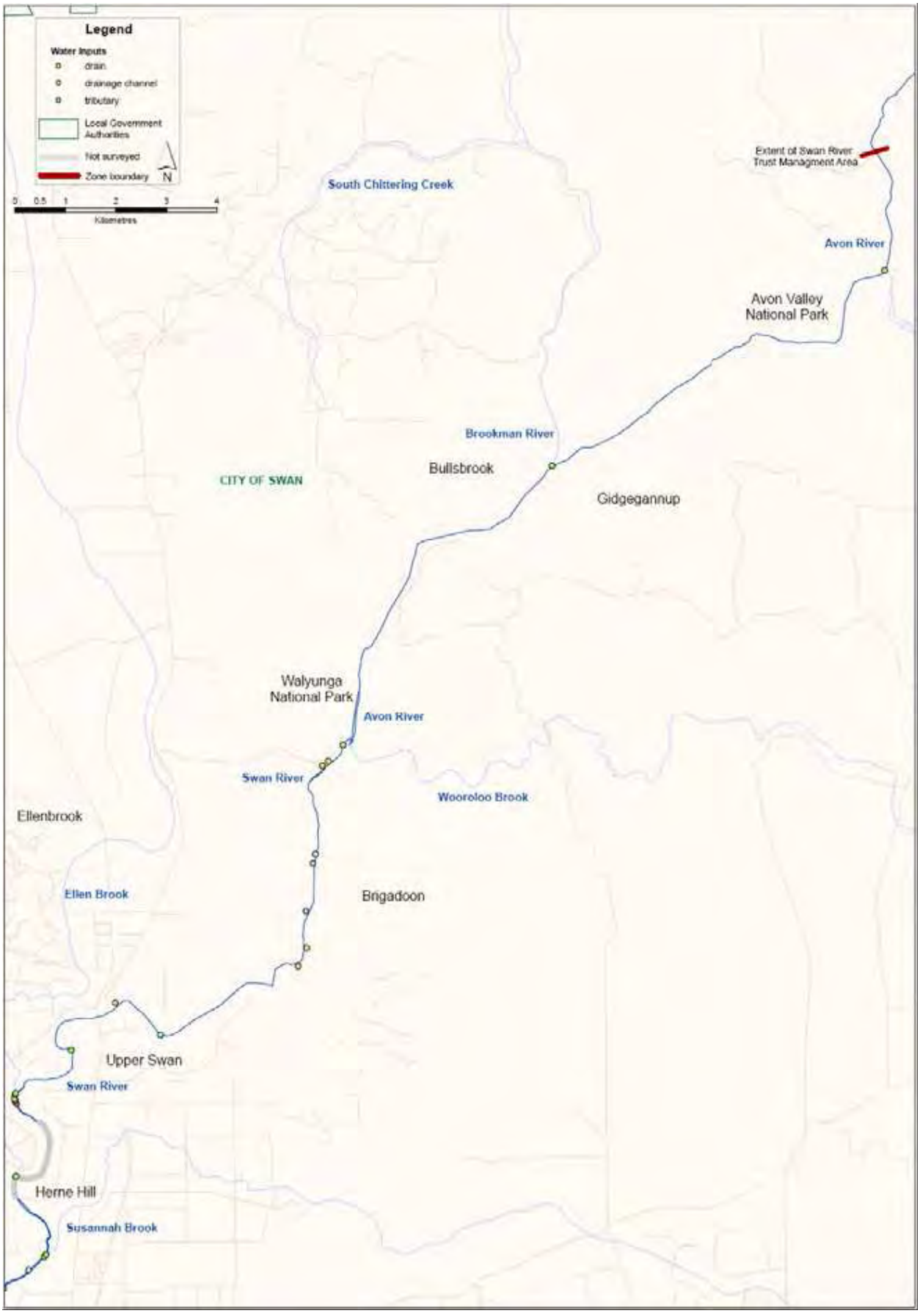


Figure 3.4 Discharge points along the upper Swan

3.2.4.3 Canning (Zone 3)

Along the Canning, evidence of erosion can be masked due to the extensive weed coverage obscuring the view. Approximately half (47 per cent) of the Canning foreshores exhibited a low level of bank erosion and only 11 per cent of the foreshores exhibited a high level of erosion (Table 3.19; Figure 3.5). Evidence of erosion was typically observed on the outside of meander bends, at tributary confluences, in active floodplain areas, adjacent to woody debris and immediately upstream of riffles.

The presence of erosion on the upper bank is typically a result of significant flow events. The majority of the banks exhibited no upper bank scarping (85 per cent) with a third of the banks experiencing low to moderate scarping (Table 3.20). Only 5 per cent of the upper shores had high levels of erosion with scarping, with the majority of these occurring on the outside of meander bends.

Table 3.19 Longshore extent of bank erosion along the Canning

	Low (<33%)		Moderate (33–67%)		High (>67%)	
Zone	**km**	**% Zone**	**km**	**% Zone**	**km**	**% Zone**
Total Canning	**30.9**	**47%**	27.7	42%	7.6	11%

Table 3.20 Longshore extent of upper-shore scarping along the Canning

	None		Low (<33%)		Moderate (33-67%)		High (>67%)	
Zone	**km**	**% Zone**	**km**	**% Zone**	**km**	**% Zone**	**km**	**% Zone**
Total Canning	**56.5**	**85%**	6.4	10%	3.0	5%	0.2	0%

The majority of banks within the Canning are influenced by the presence of trees. However, in many areas, there has been an opportunistic invasion of weeds as trees have been removed. In these areas, weed-removal programs can mobilise sediments on the banks if the bank is left exposed and revegetation and bioengineering are not conducted simultaneously with the removal of the weeds. Approximately 26 per cent of reaches in the Canning would be assisted by significant revegetation.

A total of 174 discharges were noted in the areas assessed in the Canning, with 127 drains, 37 drainage channels and 10 tributaries (Figure 3.6). The majority of the drains had an erosive impact with scour in front of the drain (61 drains) and / or bank retreat (36 drains) (Table 5H in Appendix 6). A total of 77 per cent of the 164 drains and drainage channels had some impact on the foreshore (Table 5I in Appendix 6). Many of the drains (52 per cent) have design features to reduce impacts and gross pollutants entering the system including headwalls, scour apron, plinths and pollutant traps. The most common design feature incorporated in drainage structures were headwalls (73 drains). The large percentage of drains that were having an impact on the foreshore suggests that further erosion control management would be appropriate for this Zone.

Significant quantities of sediment are also delivered to Geomorphic Units 4 and 5 through the drainage network through downstream sediment transport sediment input from uncontained construction sites. Furthermore, drainage flowing over the banks can destabilise banks and exacerbate erosion delivering additional sediment to the system.

In addition to the discharges to the Canning, there are numerous water abstraction locations along the Canning and Southern rivers within Units 3-6; the volume abstracted is licensed, but not regulated. This water abstraction reduces the already minor flow entering the system from controlled releases into the Canning River.

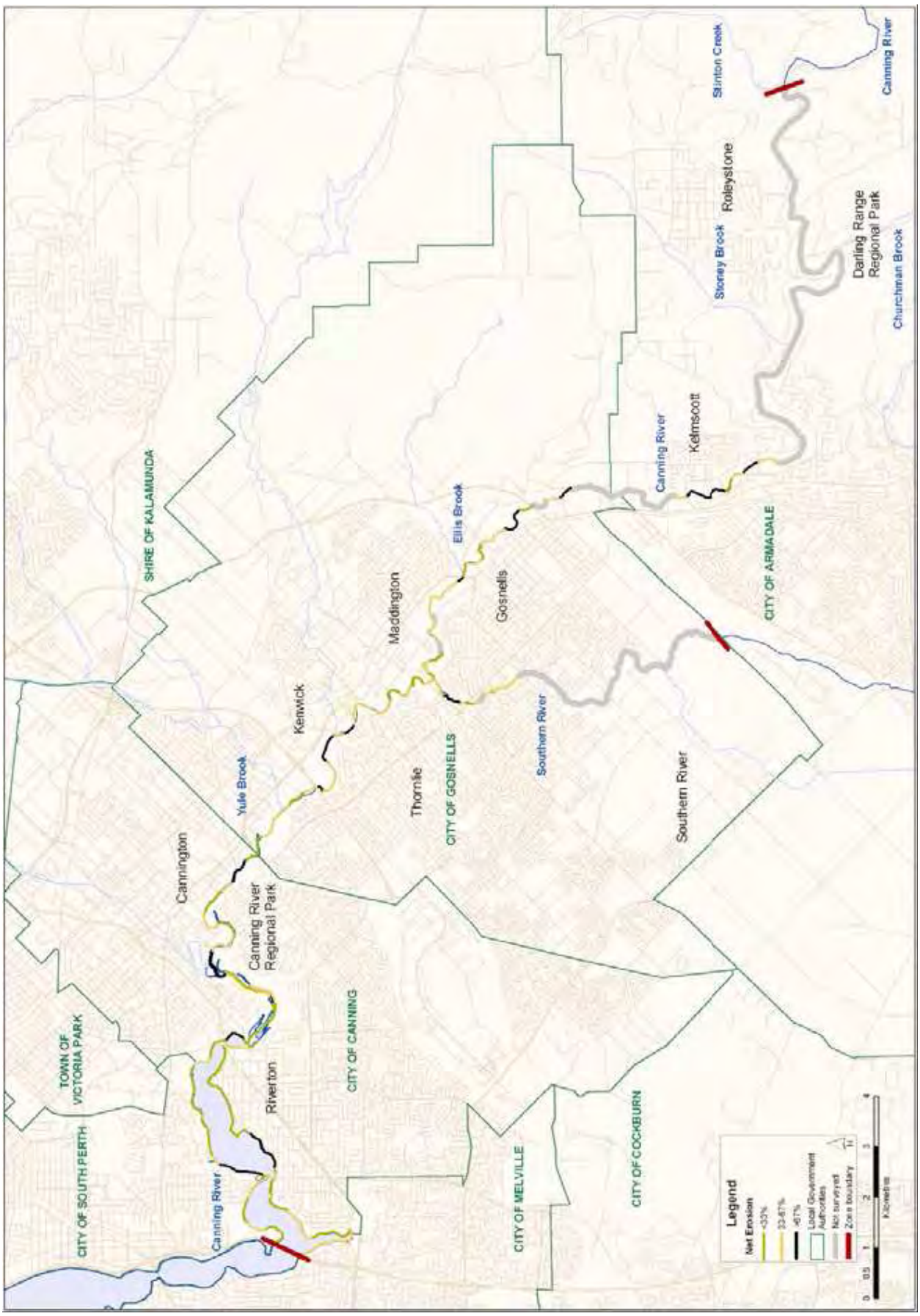


Figure 3.5 Extent of foreshore erosion along the Canning

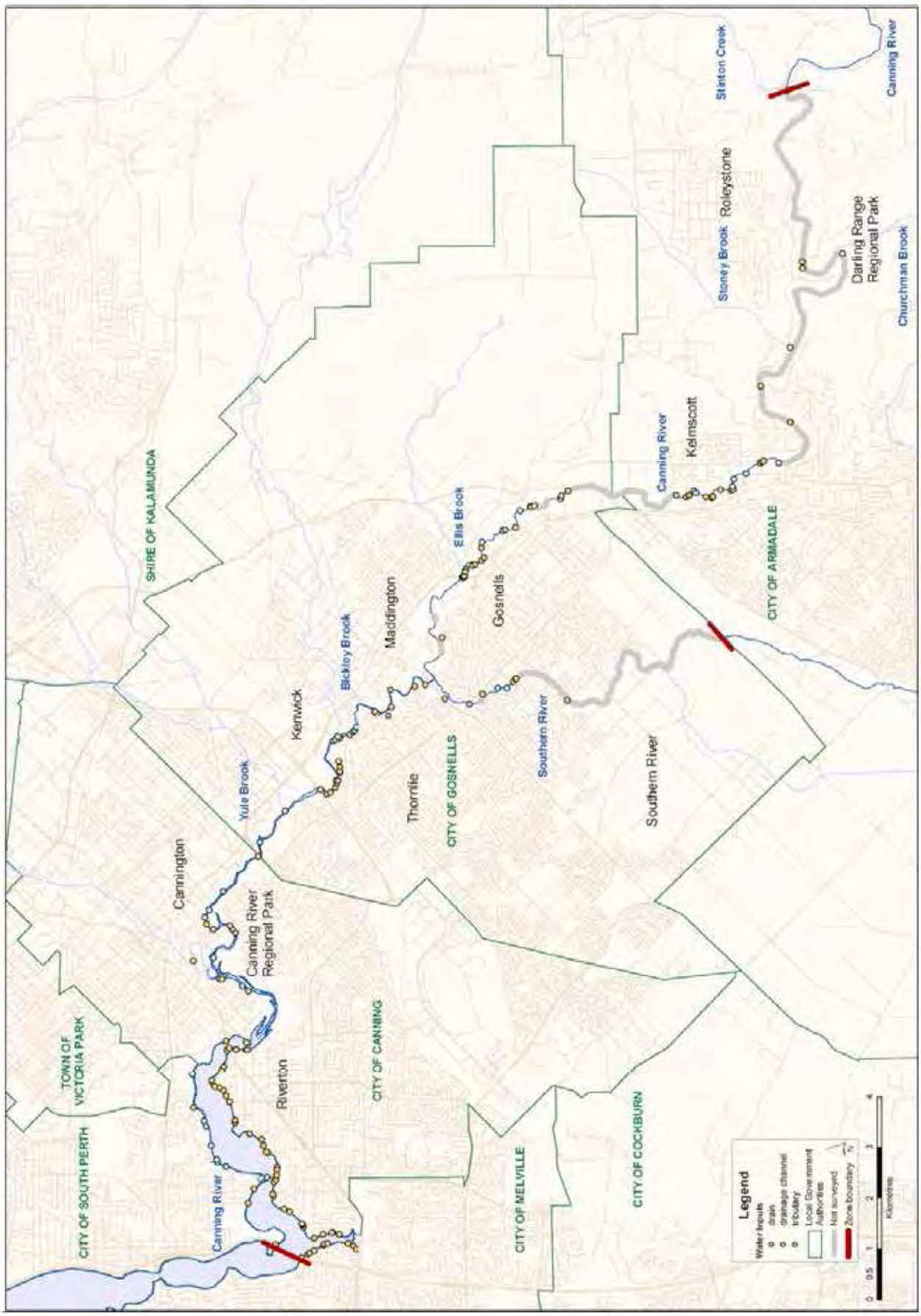


Figure 3.6 Discharges along the Canning

3.2.5 Condition and function of built structures

3.2.5.1 Estuary (Zone 1)

Some 174 foreshore protection structures were identified along the estuary shoreline, covering approximately 25 km of foreshore (Appendix 7). Considering the structures by length of protected shore, 48 per cent of structures were identified as functioning well under existing conditions, with 41 per cent experiencing only minor sediment loss (Figure 3.7). Approximately 11 per cent of the structures were performing poorly. The majority of poorly performing structures are believed to have reached the effective limit of their structural life.

On the basis of the length of protected shore, 27 per cent (6.7 km) of structures were in good condition and would benefit from an annual maintenance program, 32 per cent (8.2 km) were in fair condition and in need of immediate maintenance, and 26 per cent (10.6 km) were in poor ndition, requiring rebuilding or removal (Figure 3.8). The majority of structural damage appears commensurate with the age of the structures and their expected pattern of degradation.

The majority of structures that are in poor condition have reached the effective limit of their structural life. Notable exceptions include gabion walling along Mounts Bay Road and the series of armoured groynes along Como Foreshore. It appears that inadequate design and construction are responsible for the gabion failure along Mounts Bay Road. For Como foreshore, the design required ongoing foreshore renourishment, which has not occurred with the originally intended frequency.

The function of the existing foreshore protection structures along the Estuary Zone is generally better than their condition. In most cases, this is because even a badly degraded structure will assist in the retention of foreshore sediments. As a result, even a poorly designed or constructed structure may function adequately for a number of decades. However, foreshore protection structures are susceptible to damage due to changing bed levels, whether through undercutting or downdrift erosion. Foreshore protection structures therefore require careful design where there may be large variations in alongshore sediment supply, or variations in shore orientation. The most critical areas with regard to variation in alongshore sediment supply are Como foreshore, South Perth western foreshore and Lucky Bay, Applecross. Construction of a foreshore protection system in these areas is likely to have implications further alongshore, and in fact each of these areas has a long history of progressively added works.

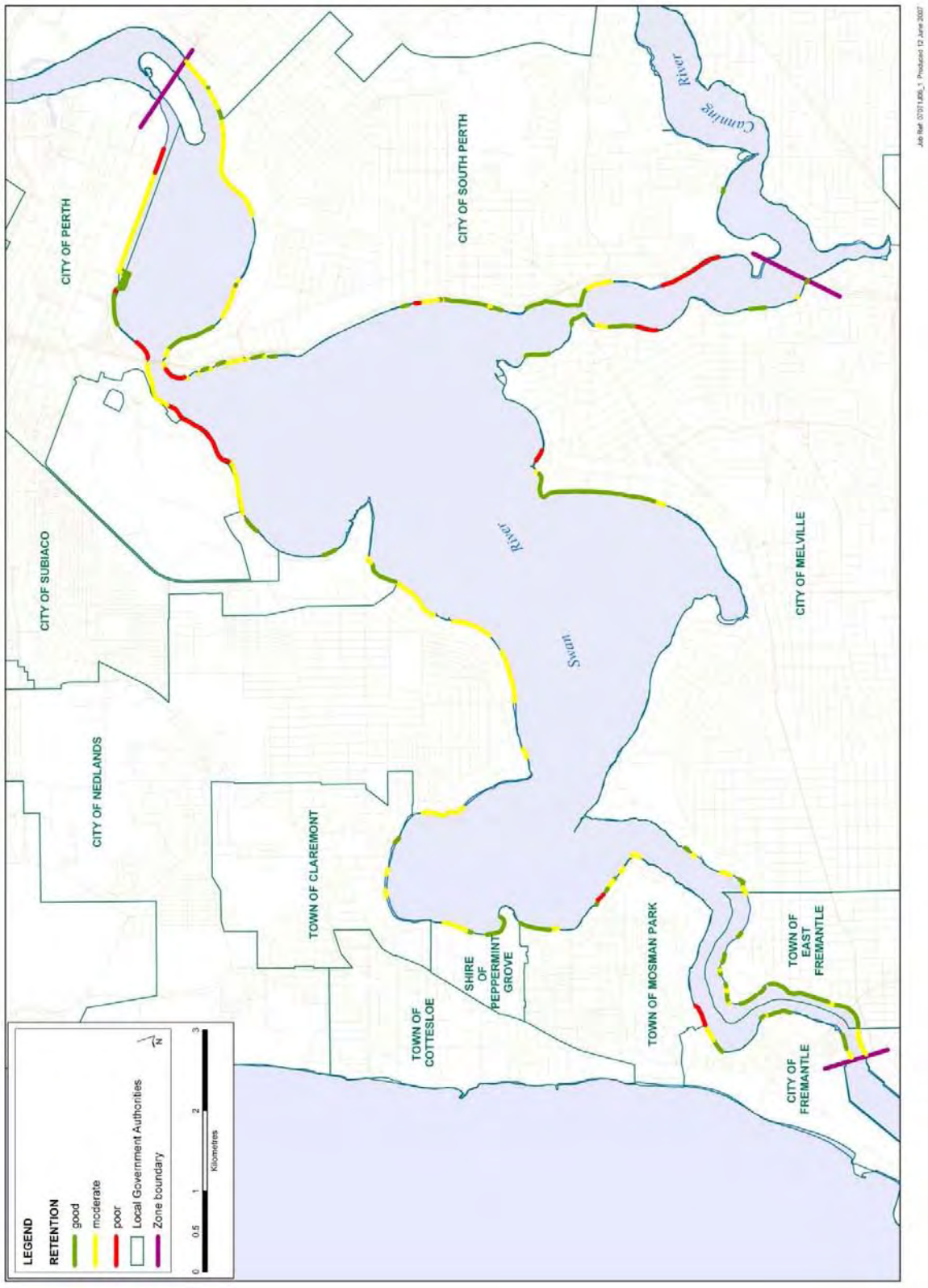


Figure 3.7 Function of foreshore protection structures along the estuary

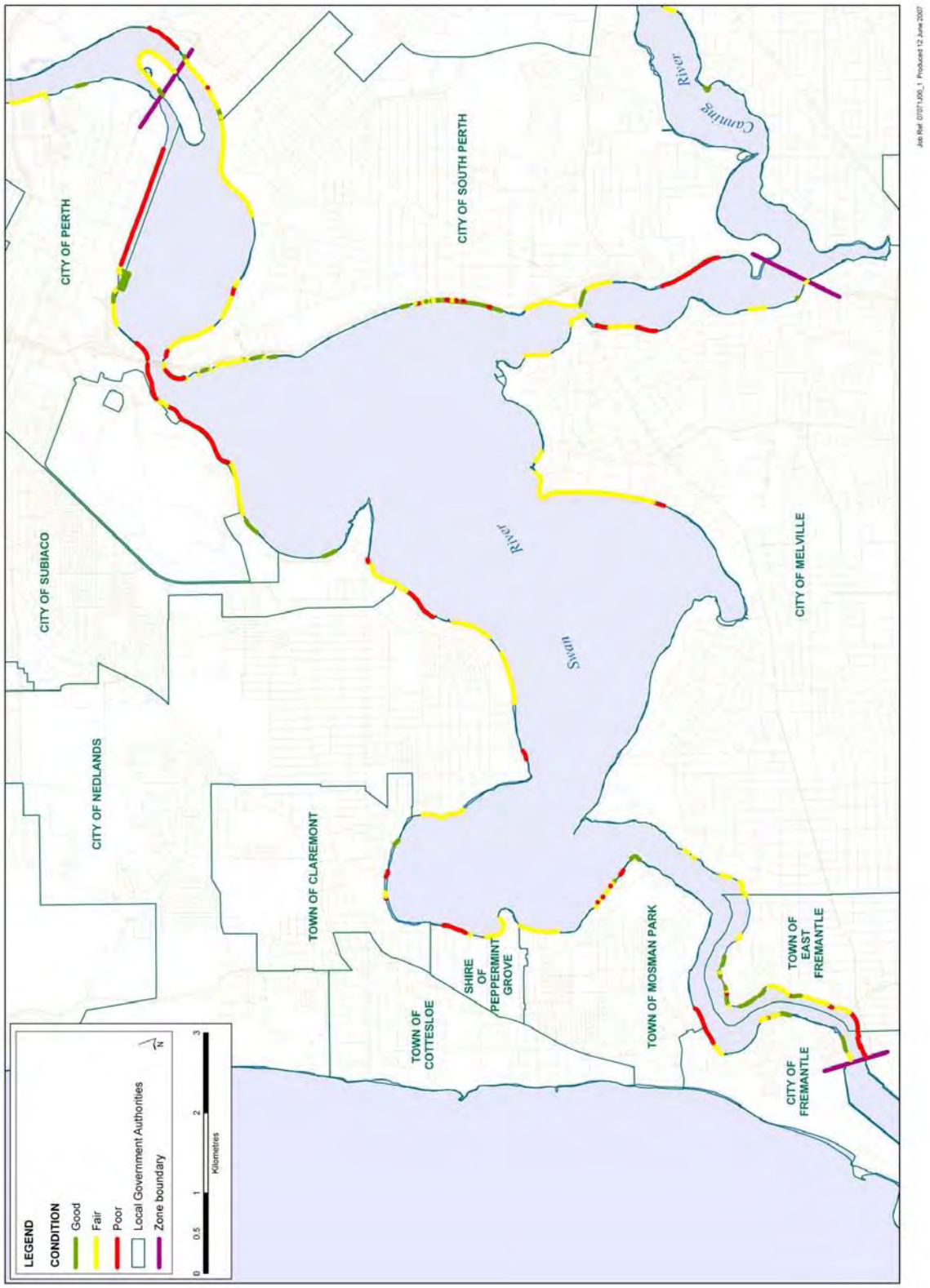


Figure 3.8 Condition of foreshore protection structures along the estuary

3.2.5.2 Swan (Zone 2)

A total of 6.75 km of structures on public land were surveyed in the Swan (Table 3.21; Appendix 7). The highest proportion of structures was generally in a fair condition (40 per cent) with 32 per cent in a poor condition (Table 3.22; Figure 3.9; Figure 3.10). The highest proportion of structures exhibited a poor function (40 per cent) (Table 3.23; Figure 3.11; Figure 3.12). This degraded condition and function can be largely attributed to the age of the structures, insufficient maintenance and inappropriate height / type of structure for the active processes at that location.

Table 3.21 Structure type along the Swan foreshore

	Length of Structure (km)					
Zone	**Revetment**	**Wall**	**Log wall**	**Gabion**	**Other**	**Total**
Total Swan	**3.26**	1.24	1.29	0.18	0.78	6.75
Percentage of Swan (%)	**48%**	18%	19%	3%	12%	

Table 3.22 Structure condition along the Swan foreshore

	Good		Fair		Poor	
Zone	**km**	**% Zone**	**km**	**% Zone**	**km**	**% Zone**
Total Swan	1.84	27%	**2.72**	**40%**	2.19	32%

Table 3.23 Structure function along the Swan foreshore

	Good		Fair		Poor		Non-retaining	
Zone	**km**	**% Zone**	**km**	**% Zone**	**km**	**% Zone**	**km**	**% Zone**
Total Swan	2.01	30%	2.01	30%	**2.65**	**40%**	0.08	1%

Half of the structures require immediate maintenance, including: replacing missing units; infilling behind the structure; repairing torn or displaced filter cloth; managing drainage behind the structure; and mitigating erosion at the ends of the structure. A third of the structures require rebuilding, replacing with an alternate structure or could potentially be replaced by a revegetated and sloped bank. A significant proportion of these structures that require replacing with an alternative structure or revegetation were log-walling. 17 per cent of the structures assessed did not require any urgent works (Table 3.24; Table 3.25).

Table 3.24 Recommended works for structures along the Swan foreshore

	No urgent works required		Immediate maintenance		Rebuild		Rebuild / remove		Potential revegetation	
Zone	**km**	**% Zone**	**km**	**% Zone**	**km**	**% Zone**	**km**	**% Zone**	**km**	**% Zone**
Total Swan	1.14	17%	**3.37**	**50%**	0.60	9%	0.95	14%	0.69	10%

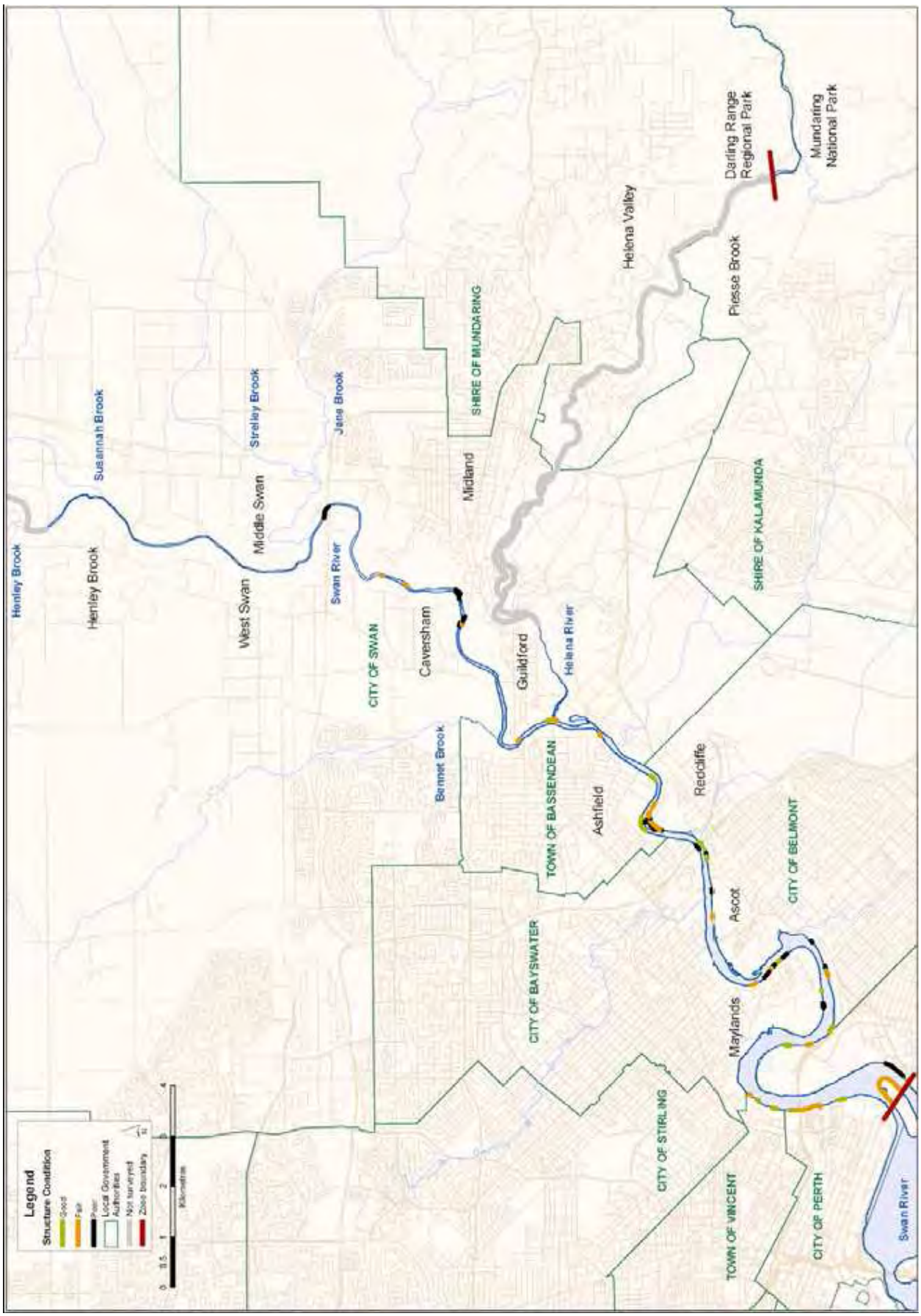


Figure 3.9 Structure condition along the lower Swan

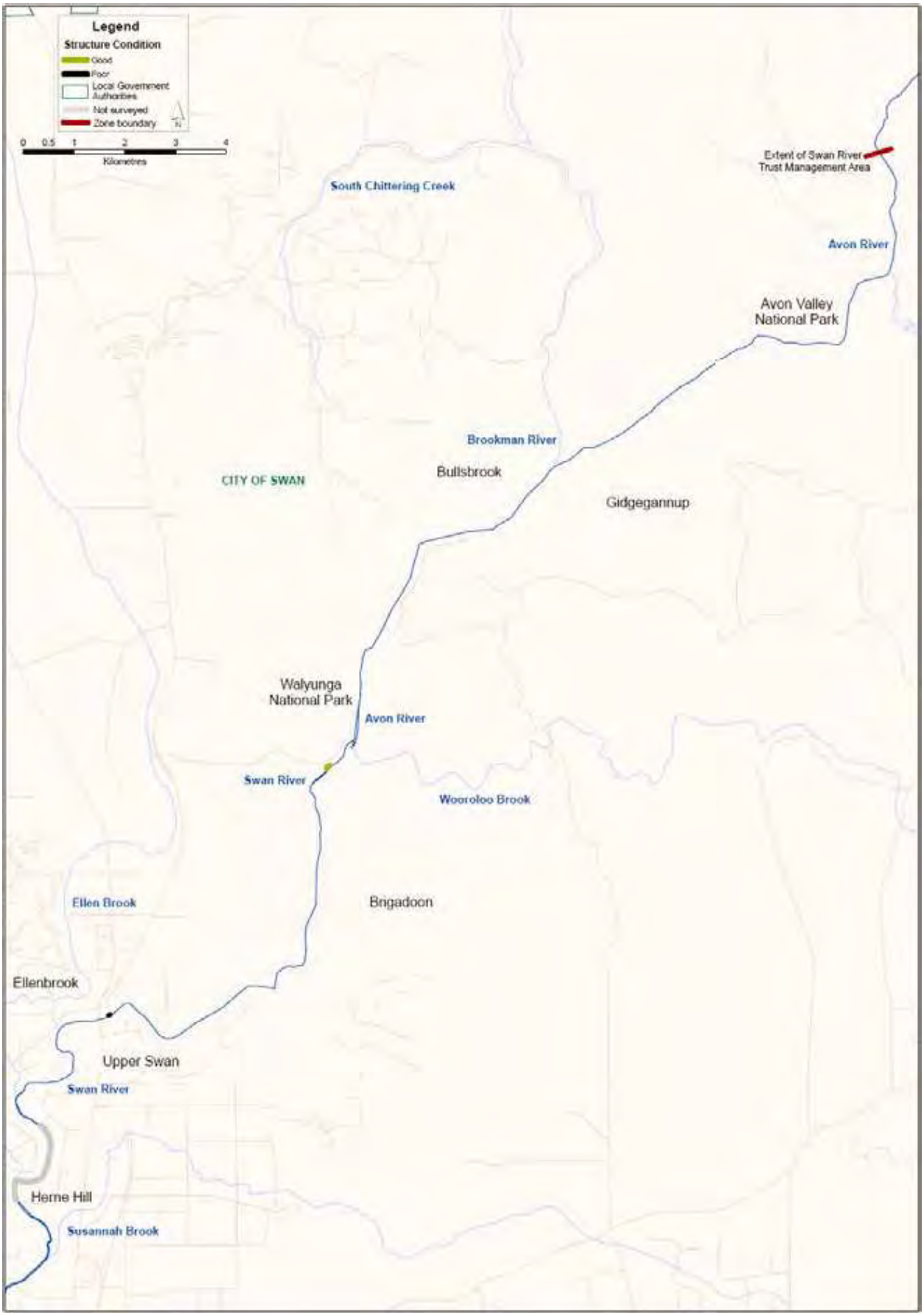


Figure 3.10 Structure condition along the upper Swan

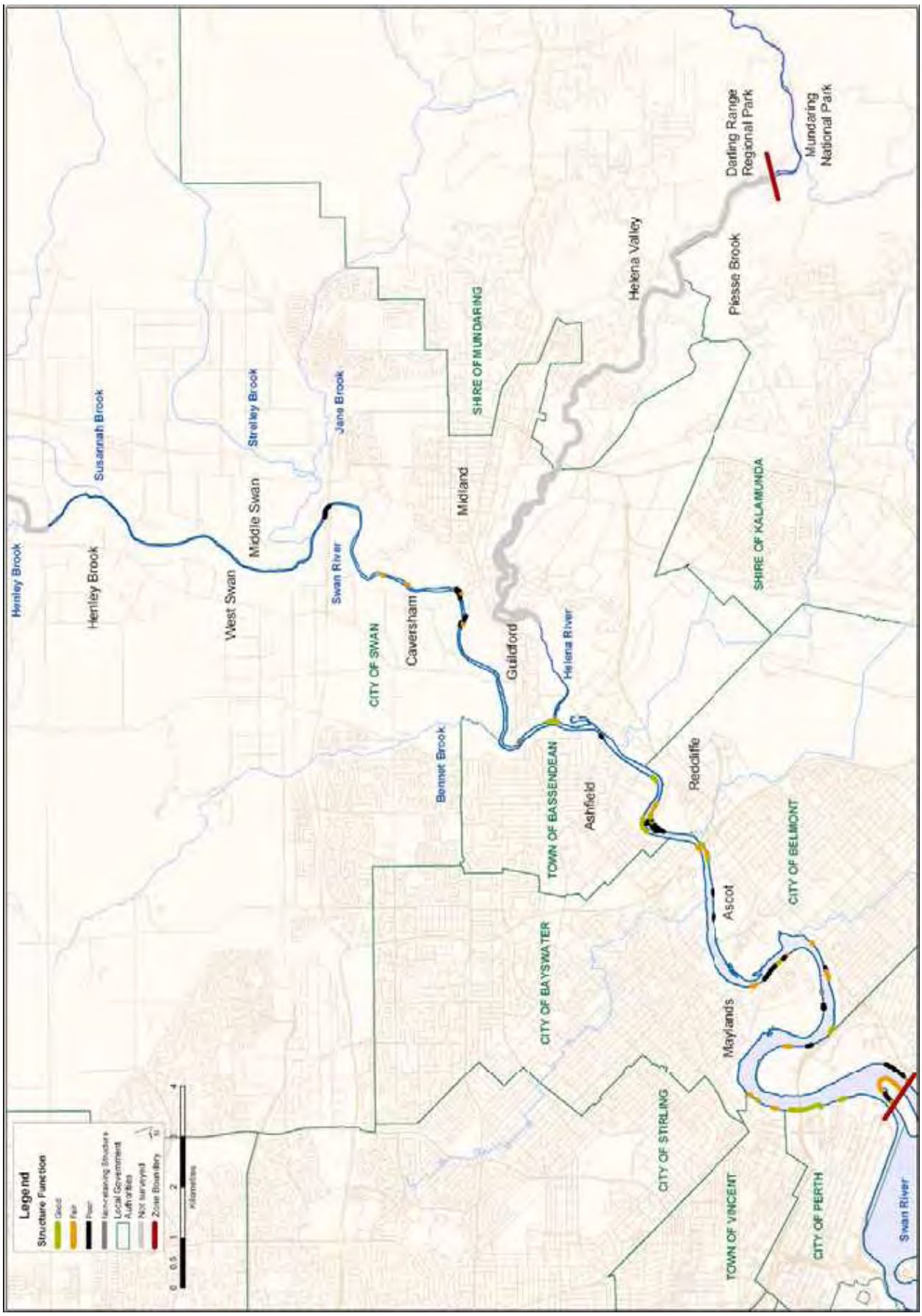


Figure 3.11 Structure function along the lower Swan

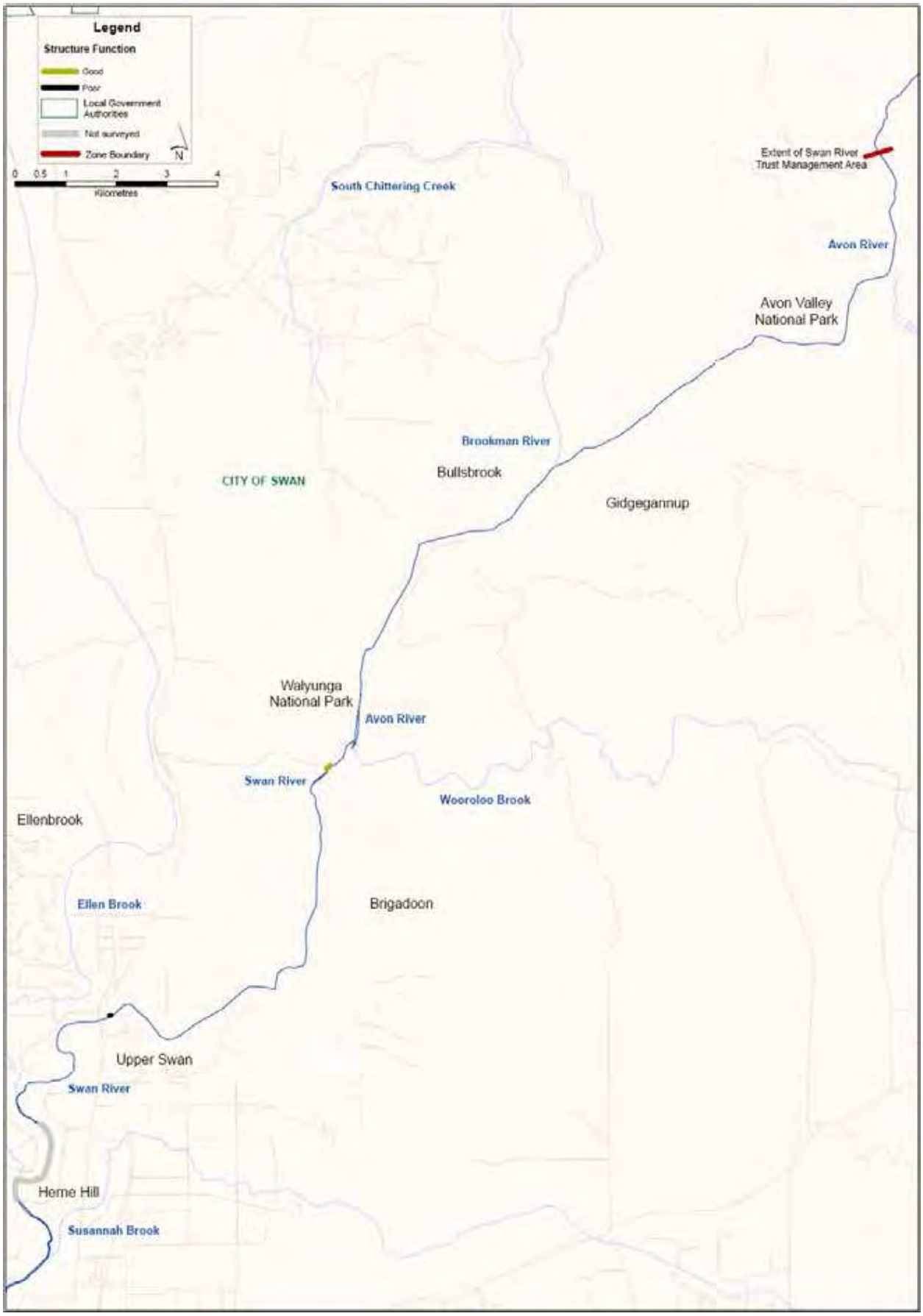


Figure 3.12 Structure function along the upper Swan

Table 3.25 Recommended works for structures within the Swan

Geomorphic Unit	General Recommendations
1	Many structures require immediate maintenance to ensure a sustained or improved level of foreshore retention.
2	Maintenance works would be required annually at the Helena River confluence following winter events. Minimal maintenance is likely to be required on bridge abutments.
3	The structures are generally in fair to poor condition, exhibiting fair to poor function. A number of structures in this unit could be removed and replaced with a revegetated and reconstructed sloped bank.
4	Few structures present.
5	Few structures present.
6	A 4 m high revetment (with 0.8 m diameter granite units) was constructed to protect recreational facilities from shoreline erosion at Walyunga. The high river flow events at this pool warranted the height and unit size of this structure that is in a good condition and functioning adequately.

3.2.5.3 Canning (Zone 3)

A total of 1.14 km of structures (on public land) were surveyed along the Canning foreshore (Table 3.26; Appendix 7). Structures were generally in a good condition (42 per cent) (Table 3.27; Figure 3.13) and exhibited a good function (56 per cent) (Table 3.28; Figure 3.14). The adequate condition and function can be largely attributed to the recent age of the structures and significant reduction in river flow processes due to dam construction and reduced natural flows. The majority (41 per cent) of the structures required no urgent works and only 11 per cent off the structures required reconstruction (Table 3.29). It is anticipated that approximately 9 per cent of the structures could be replaced by a revegetated and sloped bank.

Table 3.26 Structure type along the Canning foreshore

	Length of Structure (km)					
Zone	Revetment	Wall	Log Wall	Gabion	Other	Total
Total Canning	0.31	**0.36**	0.03	0.33	0.05	1.14
Percentage of Canning (%)	27%	**32%**	3%	29%	4%	

Table 3.27 Structure condition along the Canning foreshore

	Good		Fair		Poor	
Zone	km	% Zone	km	% Zone	km	% Zone
Total Canning	**0.48**	**42%**	0.44	39%	0.22	19%

Table 3.28 Structure function along the Canning foreshore

	Good		Fair		Poor		Non-retaining	
Zone	km	% Zone	km	% Zone	km	% Zone	km	% Zone
Total Canning	**0.64**	**56%**	0.45	40%	0.05	4%	-	-

Between the Mount Henry and Riverton Bridges (Geomorphic Unit 1), some reclamation and nearshore dredging has been undertaken. The few structures in this unit have been designed to retain the present alignment of the foreshore. The structures ranged from poor to good condition with fair to good function. Some maintenance work is required.

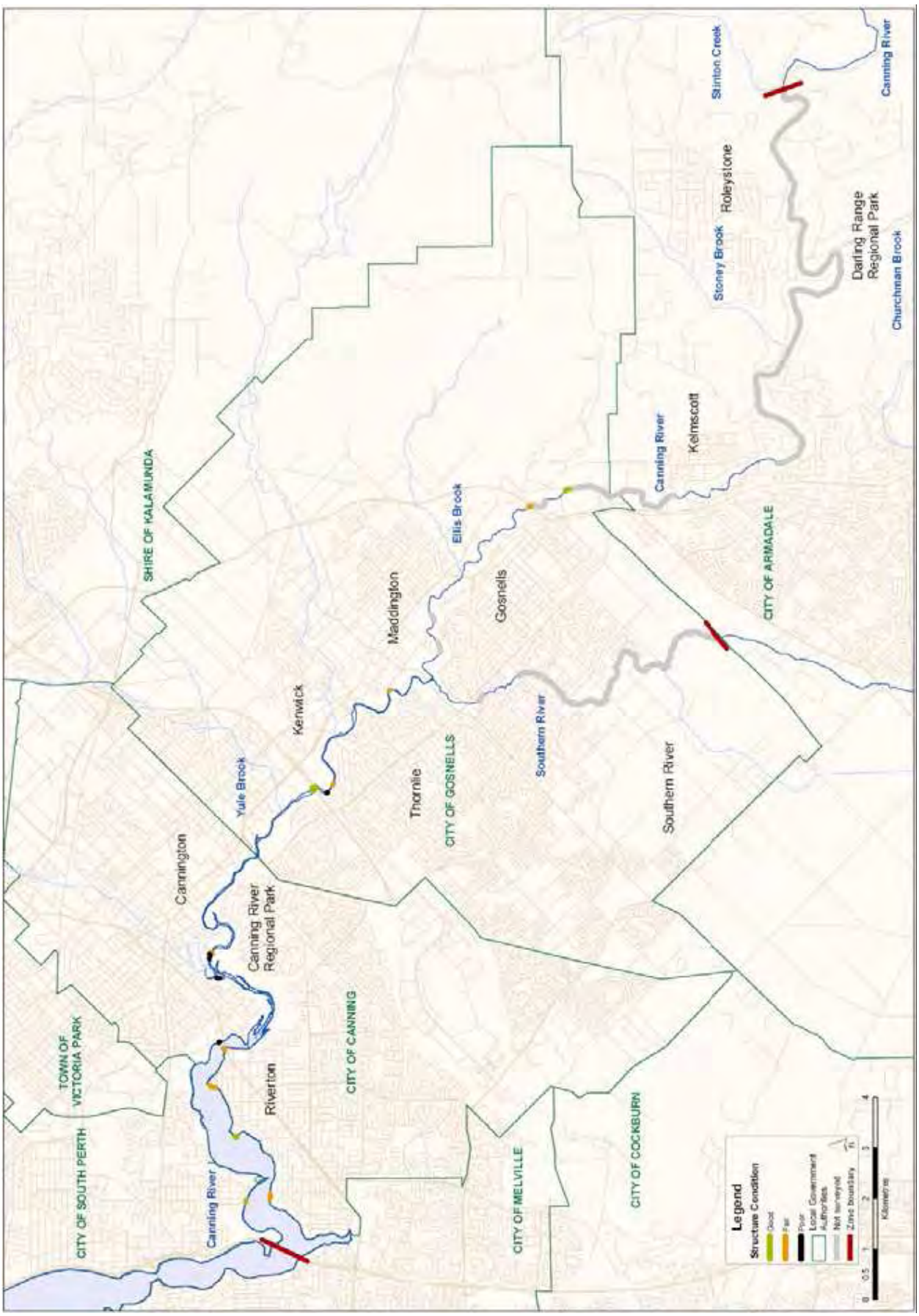


Figure 3.13 Structure condition along the Canning

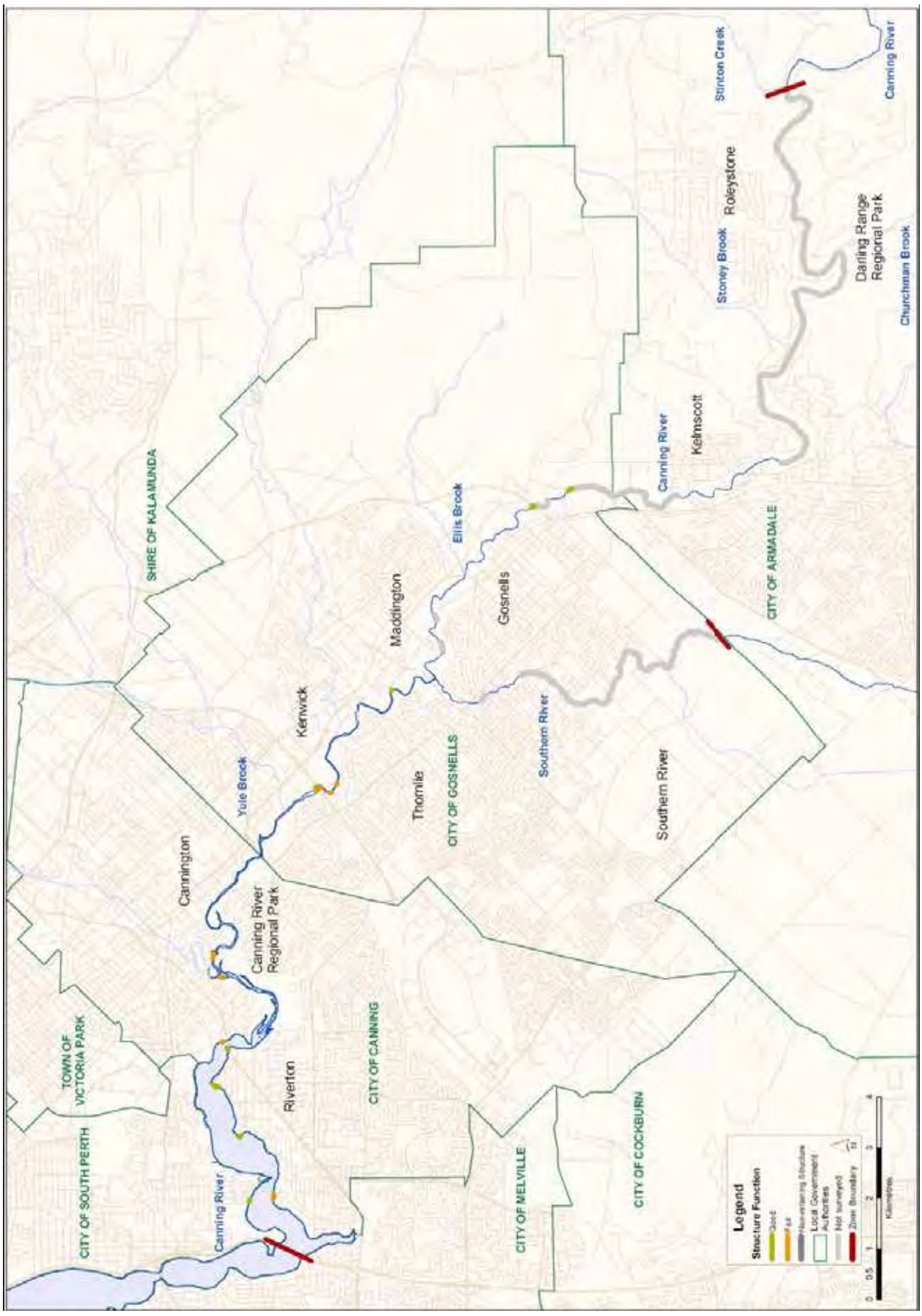


Figure 3.14 Structure function along the Canning

Table 3.29 Recommended works for structures along the Canning

	No urgent works required		Immediate maintenance		Rebuild		Rebuild / remove		Potential revegetation	
Zone	**km**	**% Zone**	**km**	**% Zone**	**km**	**% Zone**	**km**	**% Zone**	**km**	**% Zone**
Total Canning	**0.47**	**41%**	0.45	40%	0.12	11%	-	-	0.10	9%

The Kent Street Weir is located at the upstream end of Geomorphic Unit 2, within the Canning River Regional Park. In its present state, this weir could fail under a significant flood event, and improvement works are presently being reviewed.

Upstream of Kent Street Weir, the majority of structures are road, rail and pedestrian bridge abutments. Many of these were not assessed in detail as they did not significantly modify the present bank / flow characteristics. The abutments are generally in fair condition; many had missing units that have been removed to construct *ad hoc* dams. Maintenance is required, with focus on the upstream foot bridges. If the flow is permitted to increase from the present regulated levels, additional maintenance checks should be conducted.

3.3 Vegetation Assessment

Vegetation was assessed within the Trust development control area[1]. Surveyed vegetation is referred to very broadly as foreshore vegetation.

Vegetation units were firstly defined based on consideration of aerial photography and subsequently verified in the field. The principal components of the vegetation field assessment included:

1. Vegetation structure
   Percentage foliage cover of vegetation structural layers, for example, trees, shrubs, grasses, sedges, herbs and creepers were recorded together with the dominant species and proportion of weeds within each layer.
2. Condition
   Vegetation condition is equated to vegetation integrity, which considers both structure and function. Vegetation factors that contribute to condition were recorded and included life-form complexity, weed cover, crown death, local species natural regeneration and management pressures.
3. Threat of invasive species
   Particular attention was given to the presence of specific invasive species thought to present a potential invasive risk (see Appendix 2).
4. Degrading pressures
   A range of degrading pressures were recorded in the field to indicate the potential for future change.

A vegetation classification system based on the work of Specht (1970); Specht *et al.* (1974); and Beard (1973) was developed to describe vegetation type. Classification involved defining vegetation based on three components:

1. Genus of the tallest structural layer of vegetation;
2. Percentage foliage cover of the tallest layer, together with its life-form (i.e. tree, shrub, grass, sedge or herb) (classified as the vegetation formation); and
3. Most dominant stratum - that is, the stratum with the greatest percentage cover (when combined with the formation it gives the vegetation subformation). For mapping purposes and discussion, summarised subformations were used (Appendix 4).

A simple condition matrix was developed that considered the proportion of native vegetation together with life-form complexity (Table 3.30). This defined vegetation in the best condition as having low weed cover and high complexity (category 1), to the poorest condition with very high weed cover and low complexity (category 6). Three broad groupings were defined as good (1, 2a, 2b and 3), moderate (3b, 3c, 4a and 4b) and poor (4c, 5a, 5b and 6). The broad categories emphasise the importance of the proportion of native vegetation. This ensures that ecologically important vegetation such as sedgelands and samphire communities, which may have lower life-form complexities, are not overlooked as areas of good condition.

[1] The exception to this was Walyunga National Park. Only the riparian zone of approximately 20-30 m on either bank of the Swan Avon river was assessed in order to exclude the extensive dry land extent.

Table 3.30 Condition categories, based on life-form complexity and the proportion of native vegetation

Note: Increasing numbers indicate a decline in condition. Vegetation condition is broadly grouped as good = green, moderate = yellow, poor = orange.

	Proportion of native vegetation			
Life-form complexity	**71-100%**	**31-70%**	**11-30%**	**0-10%**
High	1	2b	3c	4c
Medium	2a	3b	4b	5b
Low	3a	4a	5a	6

Pressures and problems relating to vegetation are discussed based on consideration of all condition indicators, with particular attention given to the impacts on vegetation in the best condition (i.e. condition category 1) and the level of degradation and impacts on sites of regional significance.

3.3.1 Vegetation overview

Terrestrial vegetation fringing rivers and estuaries is an integral part of the riverine ecosystem. Together with submerged macrophytes and microscopic flora, fringing vegetation supports a diversity of fauna and performs a range of functions that benefit the overall ecosystem (Chambers 1987).

Fringing vegetation is described as the vegetation that borders wetlands, rivers and estuaries and is influenced by the aquatic environment (Water and Rivers Commission 2000a). The term 'fringing vegetation' is used interchangeably with 'riparian vegetation' (WRC 2000b) or 'peripheral vegetation' when discussing vegetation associated with waterways. The plant species that grow in association with waterways tolerate moist to wet soils. In estuaries, the native vegetation also tolerates saline conditions.

Fringing vegetation supports a wide diversity of fauna due to the variety of life forms and species that exist (Pen 1999). The vegetation provides food and shelter for many bird species and other small animals (Thurlow *et al.* 1986), and supports species that require both terrestrial and aquatic habitats throughout their lifecycle.

Fringing plants, particularly sedges and rushes, help to stabilise riverbanks and protect them against erosion from boat wash, river flow and surface water run-off (Chambers 1987). Sedges and rushes reduce erosion as their dense root network traps sediment, slowing its movement. They also reduce the velocity of the water as it passes through the plants, dissipating energy and reducing the erosive power of waves (Water and Rivers Commission 2000b).

Sedges and rushes remove nutrients and contaminants from runoff and river water, preventing them from contributing to algal blooms and eutrophication of estuaries (Chambers 1987). When slow flowing runoff moves through natural vegetation, soluble nutrients are absorbed by microorganisms associated with sedges (Water and Rivers Commission 2000c). Sedges and rushes may remove up to 98 per cent of nitrogen and phosphorus (Chambers 1987).

Overstorey species also contribute external sources of carbon, in the form of leafy material and bark that are food sources for some aquatic invertebrate species. In addition, woody debris in the form of fallen trees and branches provide structure and habitat along the shoreline.

Unfortunately, throughout Australia, riparian vegetation has been degraded and denuded to various degrees by human activities (Seddon 2004, Deeley and Paling 1999, Pen 1999). A greater understanding of the extent and severity of degradation is needed for effective management planning.

Pressures and problems
Fringing vegetation has markedly declined in the Swan River estuary since European colonisation in 1829 (Pen 1983). It was cleared initially for agriculture and later for urbanisation. Other threats to vegetation include grazing pressures, changes in salinity, saltmarsh degradation, introduction of weed species, and deposition and erosion of riverbanks and foreshores (Thurlow *et al.* 1986).

Where vegetation loss has occurred, hydraulic forces (including boat generated waves) are likely to have a greater erosive impact on the riverbank (Swan Catchment Council 2004). This is particularly true in the narrow upper stretches of the Swan River where the effect of boat wakes is higher (Swan Catchment Council 2004).

Clearing and grazing has encouraged weed invasion and opportunistic weed species have colonised disturbed areas before the indigenous successional species can re-establish, resulting in an understorey of exotics (Pen 1987). Furthermore, numerous invasive species have been introduced to the Perth metropolitan area. These have the ability to invade good condition foreshores and bushland and do not require site degradation for establishment (Appendix 9).

Alteration of the riparian vegetation has also resulted from changes in salinity throughout the Swan River estuary, which has increased from natural conditions, due to the removal of the rocky bar at Fremantle for harbour development. Wide scale clearing in the Avon catchment (Hodgkin 1987, Swan Catchment Council 2004) is also resulting in secondary salinity issues and invasion by salt-tolerant plants (Thurlow *et al.* 1986).

While the overall trend has been an increase in salinity, modifications to local hydrology patterns due to stormwater management have resulted in point sources of freshwater flushing in otherwise saline environments in the lower estuary. This has allowed the establishment of freshwater species in areas directly affected. Furthermore, the construction of the Kent Street Weir on the Canning River has reduced the salinity upstream of the weir due to the impoundment of freshwater and blocking of salt water intrusion.

Due to the range of degrading factors and the large scale loss of vegetation, many former vegetation communities are poorly represented or have been so severely modified that entire structural layers are largely absent or have been replaced by exotic species. This loss and replacement of native vegetation has resulted in the loss of connectivity between sites of remnant natural vegetation and the absence of riparian corridors over much of the foreshore extent. Where riparian vegetation does persist, it is often restricted to a single line of trees providing limited vegetation buffering for shore protection or habitat.

For example, significant areas of tidal mudflats and saltmarshes have been destroyed by landfill and city development, impacting on dependent fauna including aquatic macroinvertebrates, fish and other in stream fauna (Chambers 1987, Pen 1987). Loss of riparian vegetation also brings about a loss of habitat and other riparian function.

3.3.2 Vegetation description

3.3.2.1 Estuary Foreshore (Zone 1)

Grasses were the most dominant structural layer over 293 ha (78 per cent) of the Estuary Foreshore (Figure 3.15). Of this, 65.4 ha were classified as grassland having no additional structural layers of vegetation contributing more than 2 per cent foliage cover.

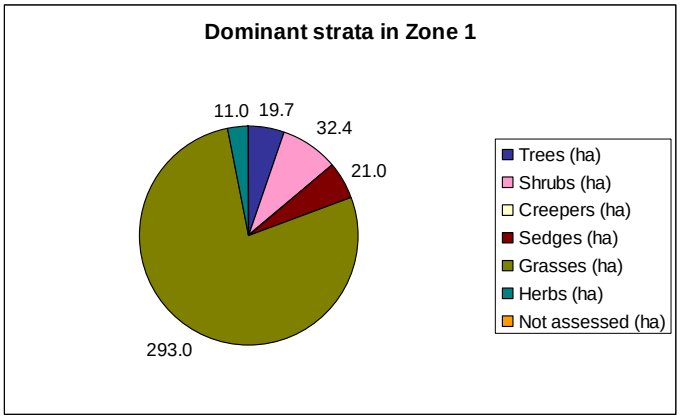


Figure 3.15 The area (ha) covered by the strata with the highest percentage cover in each vegetation unit along the Estuary Foreshore.

Throughout the Estuary Foreshore, grasses were associated with trees or shrubs over 226.2 ha. Most commonly, trees provided the tallest structural layer over a grass understorey (218.8 ha). While 18.4 ha included reasonably dense tree foliage coverage (e.g. forest, 31-100 per cent) the majority of the area (149.3 ha) included more open tree coverage of less than 30 per cent cover (e.g. woodland). Forest or woodland areas over grass were generally in the form of exotic parklands or parklands with a modified remnant overstorey, with fewer areas representing degraded remnant vegetation.

Native understorey was relatively poorly represented across the Estuary Foreshore. Sedges were the dominant structural layer across only 21.0 ha. Although sedges were recorded across an additional 74 ha, their percentage cover was often quite low and their distribution scattered across the zone.

Sedge dominated areas include Prawn Bay rehabilitation site, North Fremantle; Garungup Park, Mosman Park; Alfred Cove Nature Reserve; Pelican Point, Crawley; Point Fraser rehabilitation site, Perth; a narrow area of foreshore along Milyu Nature Reserve, South Perth; a section of foreshore opposite Deep Water Point and a narrow area at the foot of Mount Henry, Salter Point. Overall, fringing vegetation including sedges was poorly represented within the Estuary Foreshore (Figure 3.16).

A total of 84 vegetation types were defined along the Estuary Foreshore with over 50 per cent of the foreshore occupied by six vegetation types (Table 3.31). Again, the dominance of grasses within this zone is highlighted, with exotic grassland being the most prevalent vegetation type. The other five vegetation types also featured grasses within the dominant layer.

Table 3.31 Vegetation types along the estuary that account for 50% of the foreshore

Vegetation Type	Area (ha)	% of Zone 1
Exotic grassland	65.4	17
Mixed woodland with grasses	50.2	13
Exotic woodland with grasses	22.4	6
Mixed forest with grasses	21.4	6
Melaleuca woodland with grasses	20.4	5
Exotic, Agonis woodland with grasses	18.1	5
Total Estuary	197.9	52%

In addition to grasses being the dominant understorey, the overstorey often also comprised exotic species.

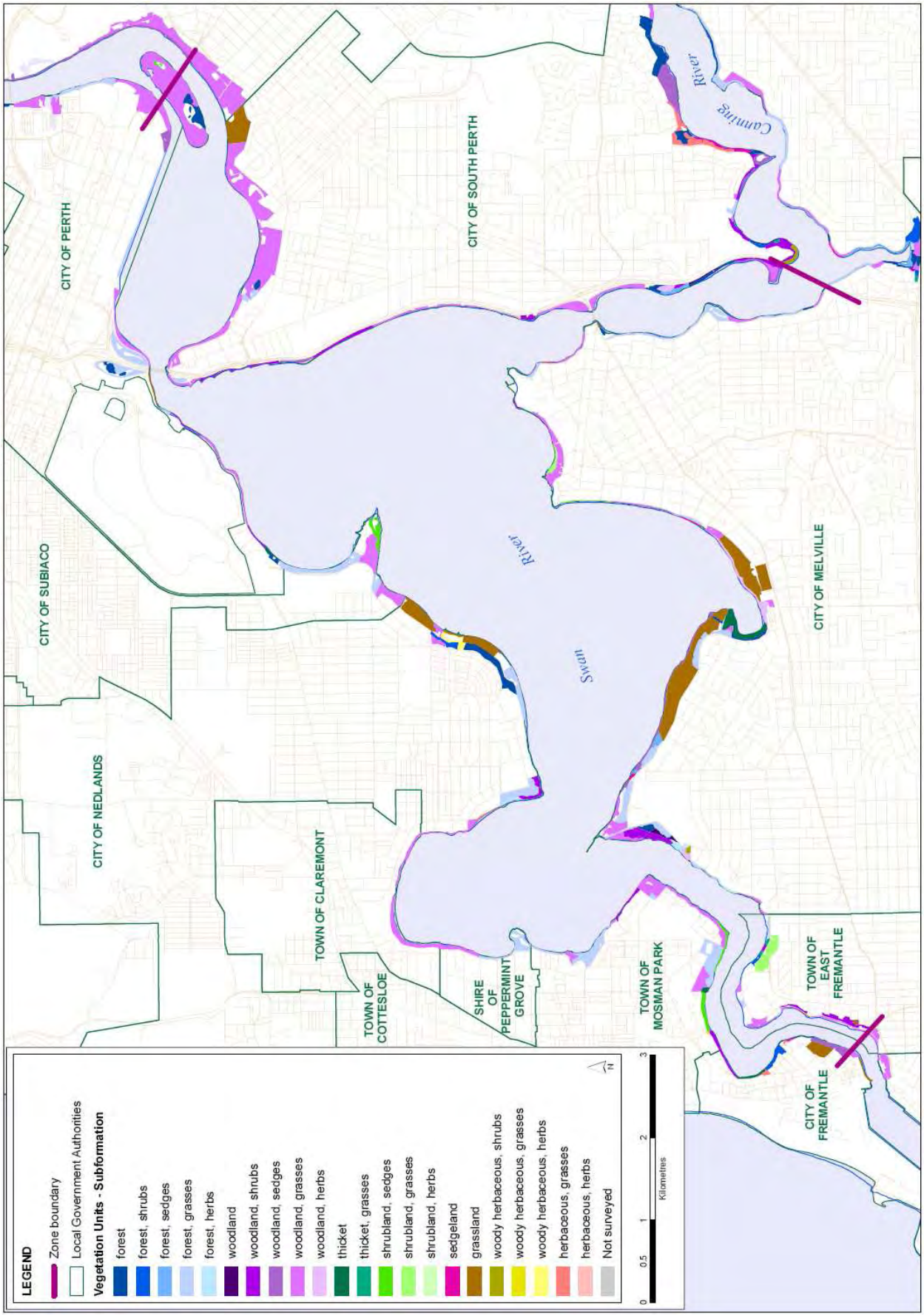


Figure 3.16 Spatial distribution of vegetation subformations along the Estuary Foreshore

3.3.2.2 Swan Foreshore (Zone 2)

Grasses were again the most dominant structural layer, covering 981 ha (70 per cent) of the Swan Foreshore (Figure 3.17). Of this, 56.3 ha featured grasses as the tallest vegetation layer with no additional structural layers of vegetation contributing more than 2 per cent foliage cover.

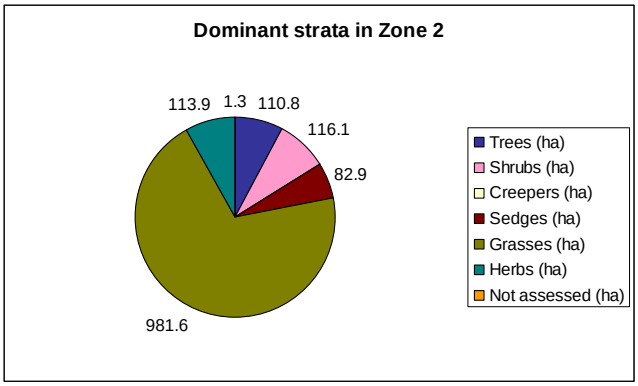


Figure 3.17 The area (ha) covered by the strata with the highest percentage cover in each vegetation unit along the Swan Foreshore.

Along the Swan Foreshore, grasses were most often overlain by tree species providing canopy cover of 2-30 per cent (560.1 ha). Areas of woodland with grasses covered large areas of the foreshore. An additional 302.2 ha (20 per cent) of grass understorey was associated with trees with a canopy cover greater than 31 per cent. Forest with grasses regularly interrupted an otherwise continuous stretch of forest vegetation that is, dominated entirely by tree species upstream of the Roe Highway crossing along the Helena River. Generally, grasses were more dominant in areas where tree canopy was more open.

Overall, trees were recorded across 1,251 ha along the Swan Foreshore. Although canopy cover ranged considerably across the zone with 513.4 ha having cover greater than 31 per cent and 738.1 ha with cover between 2 and 30 per cent. Where trees fringed the foreshore, they were often observed within a single line with limited or no understorey or native vegetation buffer behind.

The complexity of the tallest strata decreased along the foreshore between the lower Swan River and mid to upper Swan River and Helena River, and was lowest overall along the lower Avon River. Within the lower Swan River, 20 different combinations of genera were represented by the tallest strata; however, this reduced to five different combinations of genera along the lower Avon River, suggesting a more simplified canopy. The major differences within the overstorey of the lower Avon River related to percentage foliage cover of the tallest strata that is, whether it was open or closed.

Overall, sedges were relatively poorly represented along the Swan, occurring as the dominant layer across just 82.9 ha of foreshore. Areas of forest with associated sedges were confined to the lower Swan River and found in dense stands at: Berringa Reserve, Maylands; in a narrow band along the Maylands Peninsula foreshore; across expansive areas of Baigup Wetlands, Bayswater and Ascot Island foreshore (north western extent); and along Coolgardie Main drain, Garvey Park, Ascot. None were found to be dominant further north of Blackadder Creek on the Swan River (Figure 3.18 and Figure 3.19).

Sedges were not recorded as a dominant layer anywhere along the lower Avon River or Helena River, and were very poorly represented along the Swan River above the Helena River confluence. Correspondingly, grasses increased in representation on the foreshore between the lower Swan River and the mid to upper Swan River and Helena River. Grasses competed with herbs along the lower Avon River, and were almost equally dominant.

A total of 109 vegetation types were identified along the Swan Foreshore. However, over 50 per cent of the foreshore in the Swan could be accounted for by six vegetation types (Table 3.32). *Eucalyptus* was by far the dominant overstorey species, while the understorey was dominated by grasses.

Table 3.32 Vegetation types along the Swan that account for 50% of the foreshore

Vegetation Type	Area (ha)	% of Zone 2
Eucalyptus woodland with grasses	303.1	22
Eucalyptus forest with grasses	183.1	13
Mixed woodland with grasses	104.9	7
Exotic grassland	56.3	4
Eucalyptus, Melaleuca woodland with grasses	45.7	3
Eucalyptus woodland with herbs	42.5	3
Total Swan	735.6	52%

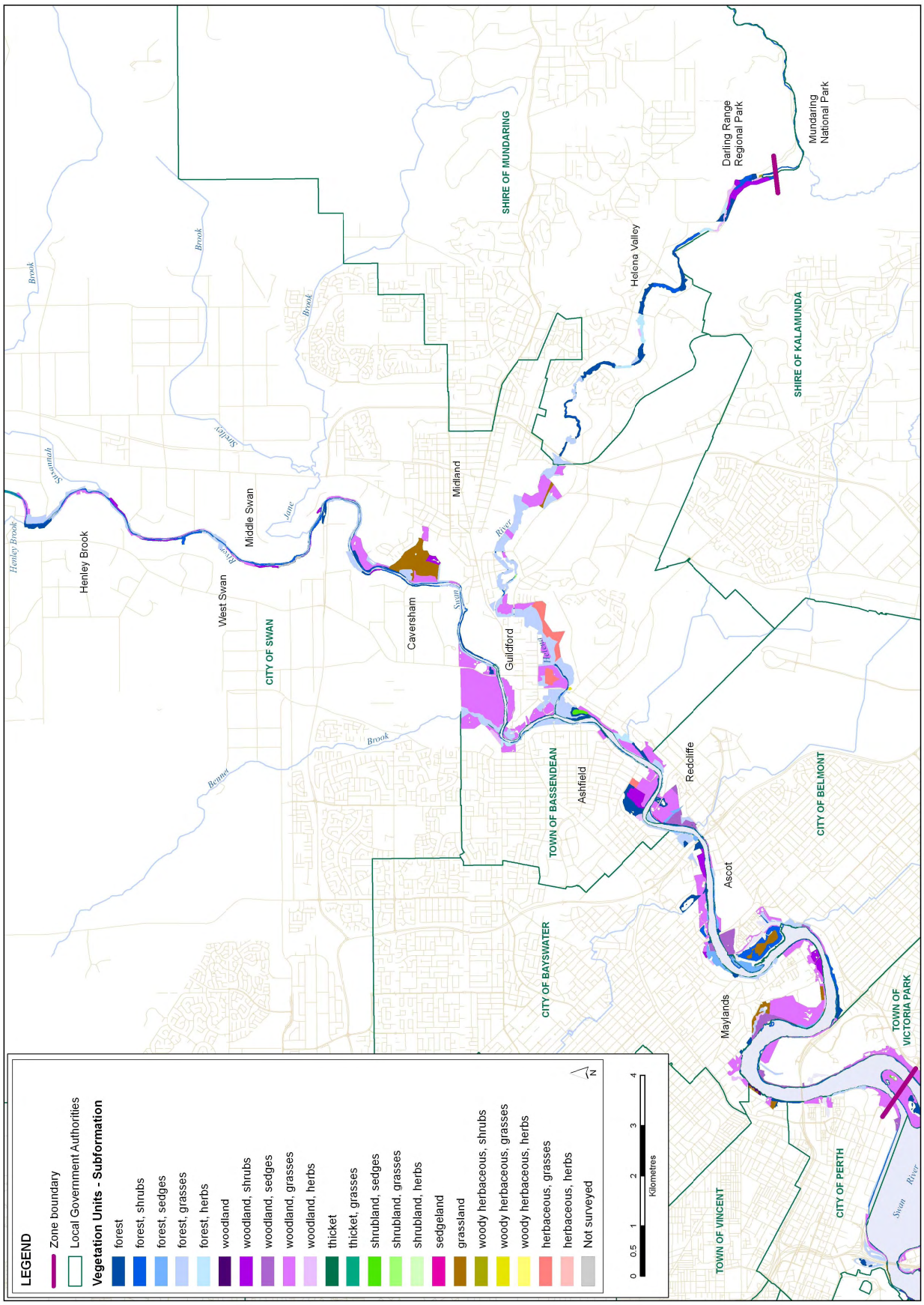


Figure 3.18 Spatial distribution of vegetation subformations along the lower Swan Foreshore

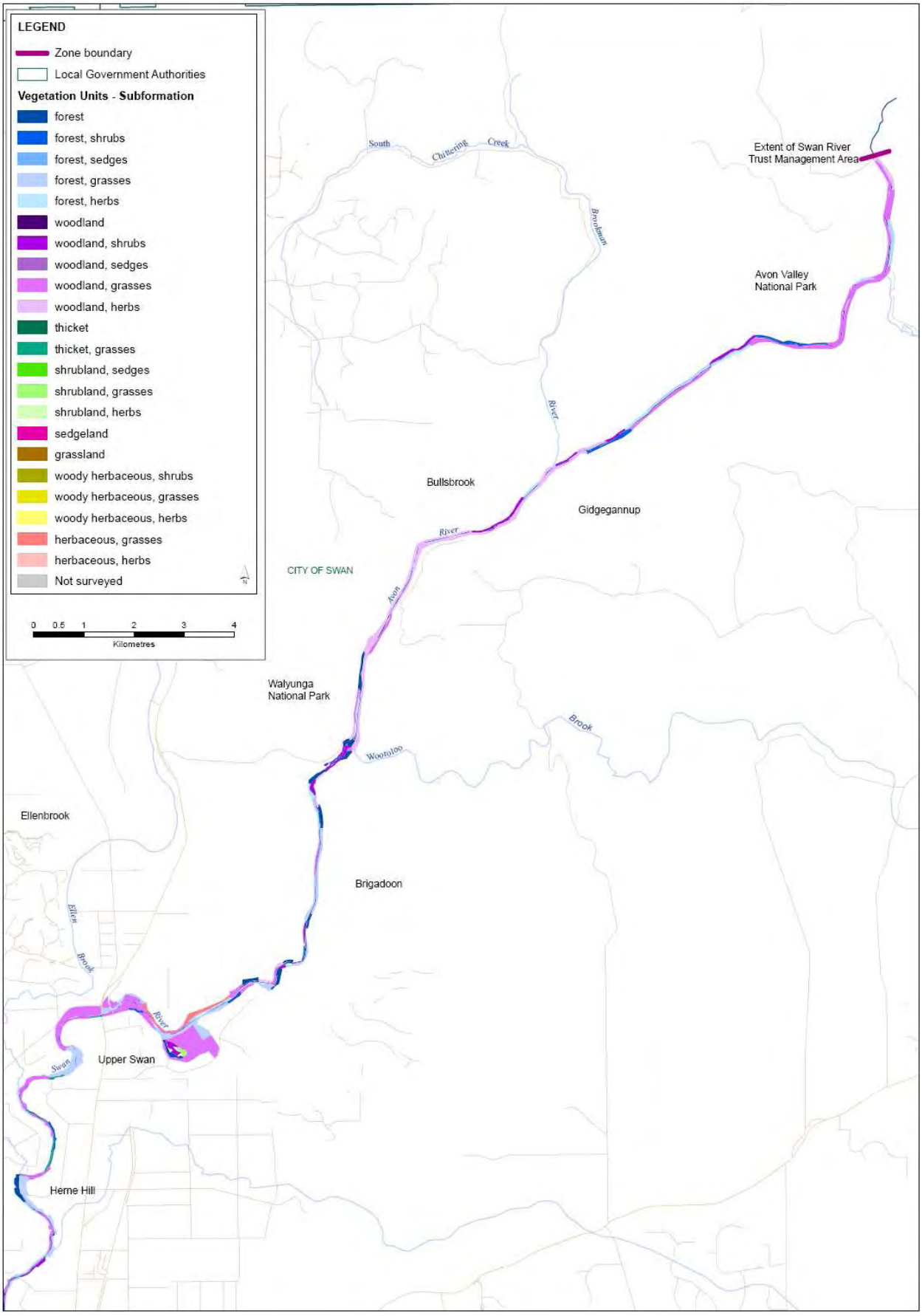


Figure 3.19 Spatial distribution of vegetation subformations along the upper Swan Foreshore

3.3.2.3 Canning Foreshore (Zone 3)

Approximately 52 per cent of foreshore along the Canning was dominated by grasses (Figure 3.20). Most often, grasses were associated with an overstorey of trees where the canopy cover was relatively open (i.e. woodland with less than 30 per cent tree foliage cover) (255.2 ha). However, grasses were still dominant over an area of 106.5 ha where the tree canopy cover was more than 31 per cent (i.e. forest).

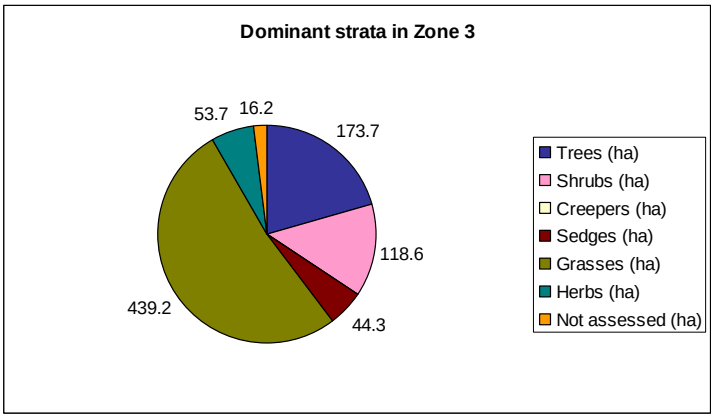


Figure 3.20 The area (ha) covered by the strata with the highest percentage cover in each vegetation unit along the Canning Foreshore

Continuous tree cover (greater than 31 per cent cover) occurred most often up river of the Canning River Regional Park, and along approximately half of Southern River. The exception to this included a number of small sections along the upper Canning where tree cover thinned to less than 30 per cent (Figure 3.21).

The relatively good tree canopy of the upper Canning River is strongly associated with a grass understorey. This most likely reflects the greater proportion of private property and the residential and rural landscape which has significantly encroached upon the natural landscape of the waterway.

Along the mid Canning River *Eucalyptus* and *Melaleuca* associations, mixed vegetation of three or more species, exotic genera and *Casuarina* were the most common overstorey. Overall, exotic genera were dominant or co-dominant across at least 75.3 ha. However, the canopy of the upper section of the Canning River Foreshore was far more simplified, with *Eucalyptus* and *Corymbia* accounting for the dominant or co-dominant genera together with reduced areas of an exotic dominated or mixed canopy. The Southern River foreshore canopy was most similar to that of the upper Canning River.

Sedges were reasonably well represented along the lower Canning River with expansive sedgelands, often associated with trees or a woody herbaceous overstorey, recorded within the Canning River Regional Park. Large areas of sedgeland and woodland with sedges were recorded along the Salter Point foreshore from Sandon Park to Bodkin Park, Waterford Foreshore Conservation Area. Narrow sections of fringing sedgeland or woodland with sedges were also recoded across the Rossmoyne and Shelley foreshores. Sedges were not recorded as the dominant or tallest layer up river of the Canning River Regional Park.

A total of 88 vegetation types were identified, with eight vegetation types (Table 3.33) accounting for over 50 per cent of the foreshore in the Canning.

Table 3.33 Vegetation types along the Canning that account for 50% of the foreshore

Vegetation Type	Area (ha)	% of Canning
Eucalyptus woodland with grasses	136.9	16.2
Eucalyptus forest	76.9	9.1
Eucalyptus forest with grasses	76.8	9.1
Eucalyptus woodland with shrubs	32.2	3.8
Eucalyptus forest with shrubs	31.4	3.7
Mixed herbaceous with grasses	31.2	3.7
Eucalyptus forest with herbs	29.0	3.4
Mixed woodland with grasses	27.5	3.2
Total Canning	441.9	**52%**

Eucalyptus was by far the dominant genus, yet, considerable spatial variation in the complexity of the overstorey was observed between the three sections of the Canning. The foreshores of the Canning River up to the confluence with the Southern River contained considerably more variety. To some extent, this is likely to be due to the generally wider reserves allowing more dry land vegetation to be included.

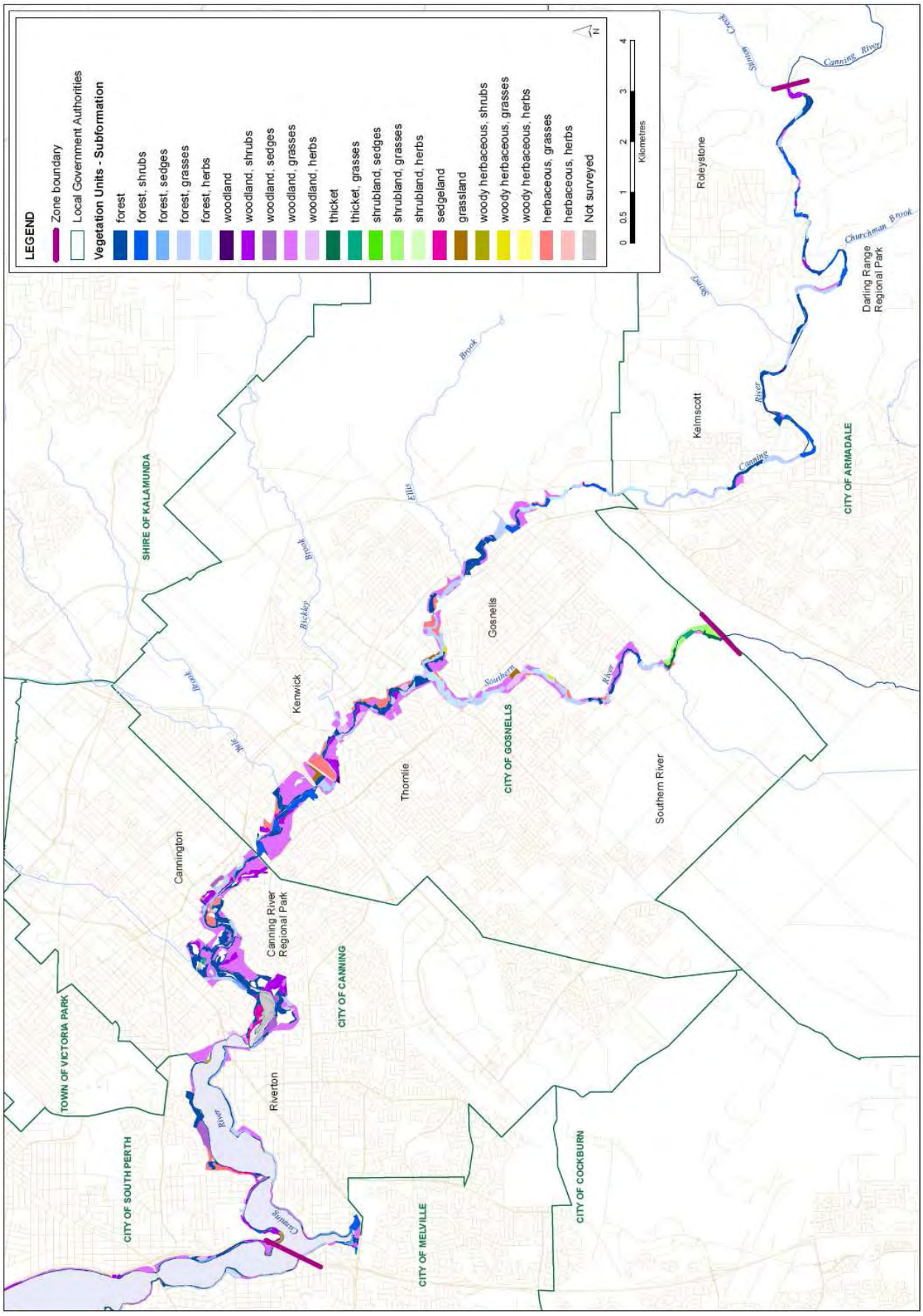


Figure 3.21 Spatial distribution of vegetation subformations along the Canning Foreshore

3.3.3 Vegetation condition

3.3.3.1 Estuary Foreshore (Zone 1)

Overall

Based on the simplified categories of condition, 45 per cent of the foreshore vegetation along the estuary was rated in poor condition, followed by 37 per cent as moderate and only 18 per cent as good (Figure 3.22; Appendix 10).

Sedgelands and samphire

In the 21 ha of foreshore dominated by sedges, 73 per cent was classified as good condition while 25 per cent was considered moderate and 2 per cent poor. Samphire vegetation was more poorly represented than sedges, with only 6.2 ha of samphire dominant shrubland recorded along the Estuary Foreshore. Despite its extremely poor representation, all areas were considered to be in good condition, with the majority having a medium level of life form complexity and low weed coverage.

Regionally significant vegetation

Approximate 20 ha of foreshore is protected in Department of Environment and Conservation managed reserves. Within those, the vegetation is generally in good condition (Table 3.34). The exception is the Alfred Cove Nature Reserve, where almost 50 per cent of vegetation is in a moderate or poor state. Comparably, Bush Forever sites are less well managed, having a large proportion of their area comprising moderate or poor condition vegetation.

Table 3.34 Condition of regionally significant vegetation along the estuary

DEC Managed Conservation Reserve					
Identifier	**Location Description**	**Good (ha)**	**Moderate (ha)**	**Poor (ha)**	**Total (ha)**
(35066)	Alfred Cove Nature Reserve	5.8	1.8	2.8	10.4
(33803)	Milyu Nature Reserve	3.0	0.0	0.1	3.1
(40891)	Swan Estuary Marine Park	2.5	0.0	0.0	2.5
Perth Bush Forever Sites					
Identifier	**Location Description**	**Good (ha)**	**Moderate (ha)**	**Poor (ha)**	**Total (ha)**
(BF 221	Point Resolution Reserve, Dalkeith	1.9	6.1	0.0	8.0
(BF 227)	Mount Henry bushland, Salter Point	4.3	2.3	0.0	6.5
(BF 329)	Point Heathcote foreshore, Applecross	0.1	0.5	0.0	0.6
(BF 331)	Blackwall Reach, Point Walter, Alfred Cove and adjacent bushland, Bicton to Applecross	18.9	18.4	43.7	81.0
(BF 334)	Chidley Point and adjacent bushland, Mosman Park	1.8	8.9	2.5	13.1
(BF 335)	Minim Cove, Mosman Park	0.4	8.4	2.2	11.1
(BF 402)	Pelican Point, Crawley	5.6	7.8	0.0	13.4
(BF 403)	Peppermint Grove foreshore	0.0	2.6	0.0	2.6

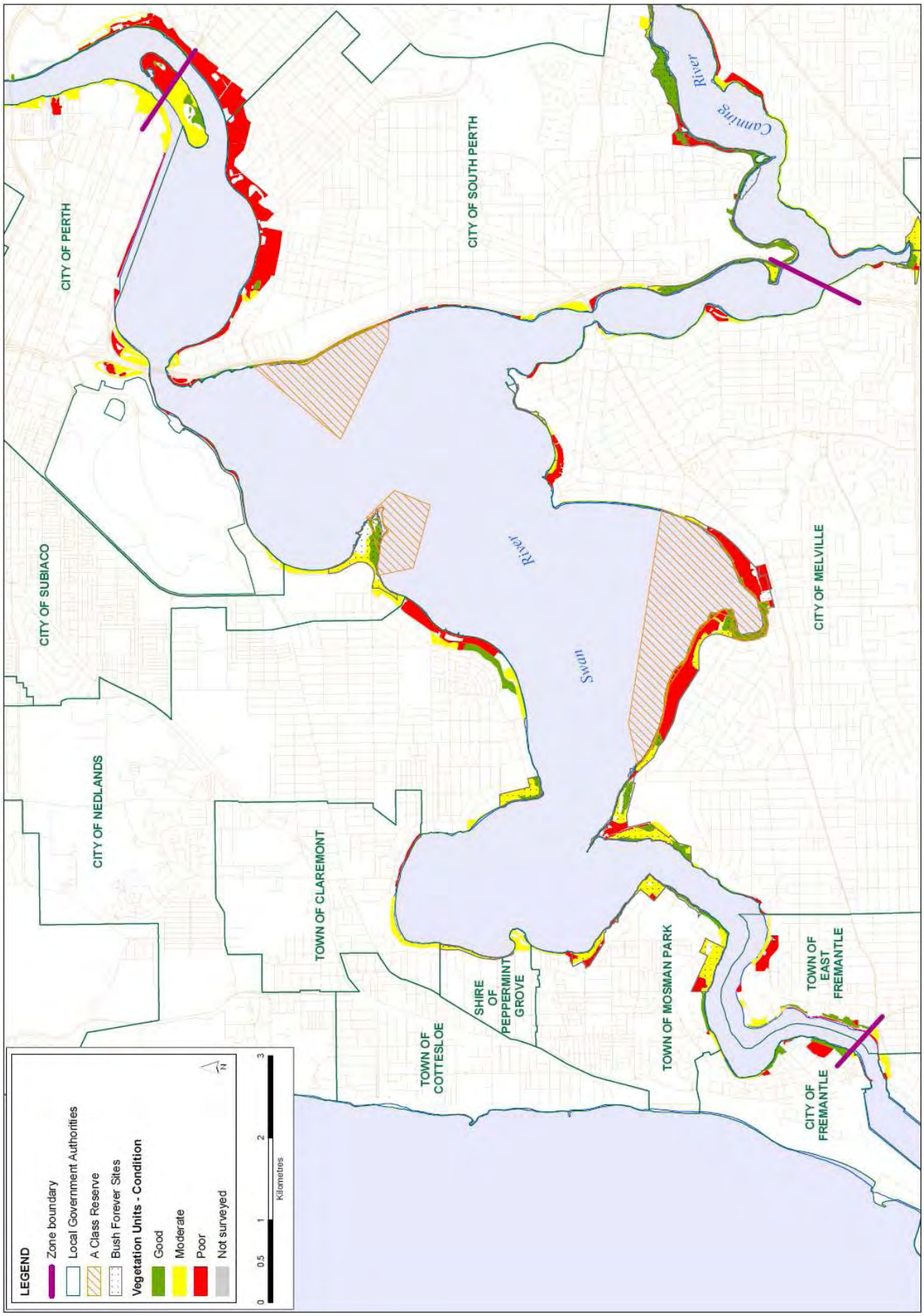


Figure 3.22 Summary of vegetation condition along the Estuary Foreshore

Degrading Factors

Invasive species

Large areas of foreshore along the estuary had 71-100 per cent cover of weeds. Highly weed infested areas included South Perth, Attadale and Nedlands foreshores and generally corresponded to the open exotic playing fields. Areas of low weed cover were located at Alfred Cove, parts of Rocky Bay and Como Foreshore (Figure 4.9). Dominant invasive species considered to represent a medium to high risk of invasiveness included Guildford grass (*Romulea rosea*), Veldt grass (*Ehrharta calycina*), Wild turnip (*Brassica tournefortii*) and Black flag (*Ferraria crispa*).

Diminished regeneration and crown death

Of the 287 ha of foreshore recorded to contain trees as a structural layer, a staggering 75 per cent was observed as not showing any evidence of local species tree regeneration. Occasional regeneration was recorded within 64.6 ha (23 per cent), where as only 6.9 ha (2 per cent) was recorded as supporting common to abundant regeneration of local tree species. Overall, 11.9 ha (4 per cent) showed signs of significant crown death (Figure 3.24).

Similarly, of the 165 ha where shrubs did occur, no regeneration was recorded across 71.3 ha (43 per cent), however, a greater proportion of area supporting shrubs was recorded as showing an occasional level of regeneration (68 ha, or 41 per cent). Approximately, 15 per cent was recorded as supporting common to abundant regeneration of local shrub species.

Inadequate management

The most significant degrading influence in the estuary, which affected over 260 ha (70 per cent) of vegetation, was the practice of maintaining mowed grass beneath established native trees without any provision for natural regeneration. Second to this was the lack of delineation between areas of maintained grass and native vegetation. Approximately 143 ha (38 per cent) containing native vegetation was observed to be impacted by grass invasion, which then had the potential to or was actively smothering native species such as sedges, herbs and shrubs. This occurrence was not limited to expansive grassed areas adjacent to remnant vegetation; but often featured within sites of revegetation and could regularly have been avoided if existing pathways were used as effective control barriers between grassed recreational areas and vegetated shorelines (Table 3.35).

Plantings of non-local indigenous species were regularly featured within approximately 35 ha of vegetation, not including the expansive areas of established and maintained grassland. Where grasslands did not dominate, approximately 30 ha was observed to be affected by trampling of understorey species and 25 ha contained regularly observed dumped rubbish.

Table 3.35 Top five management influences on vegetation along the estuary

Management Influence on Vegetation	Area (ha)	% Estuary
Mowed grass beneath established trees	265.2	70.3
No delineation between lawn and vegetation	142.7	37.8
Non-local indigenous species planted	35.4	9.4
Trampled understorey	30.5	8.1
Dumped rubbish	24.9	6.6

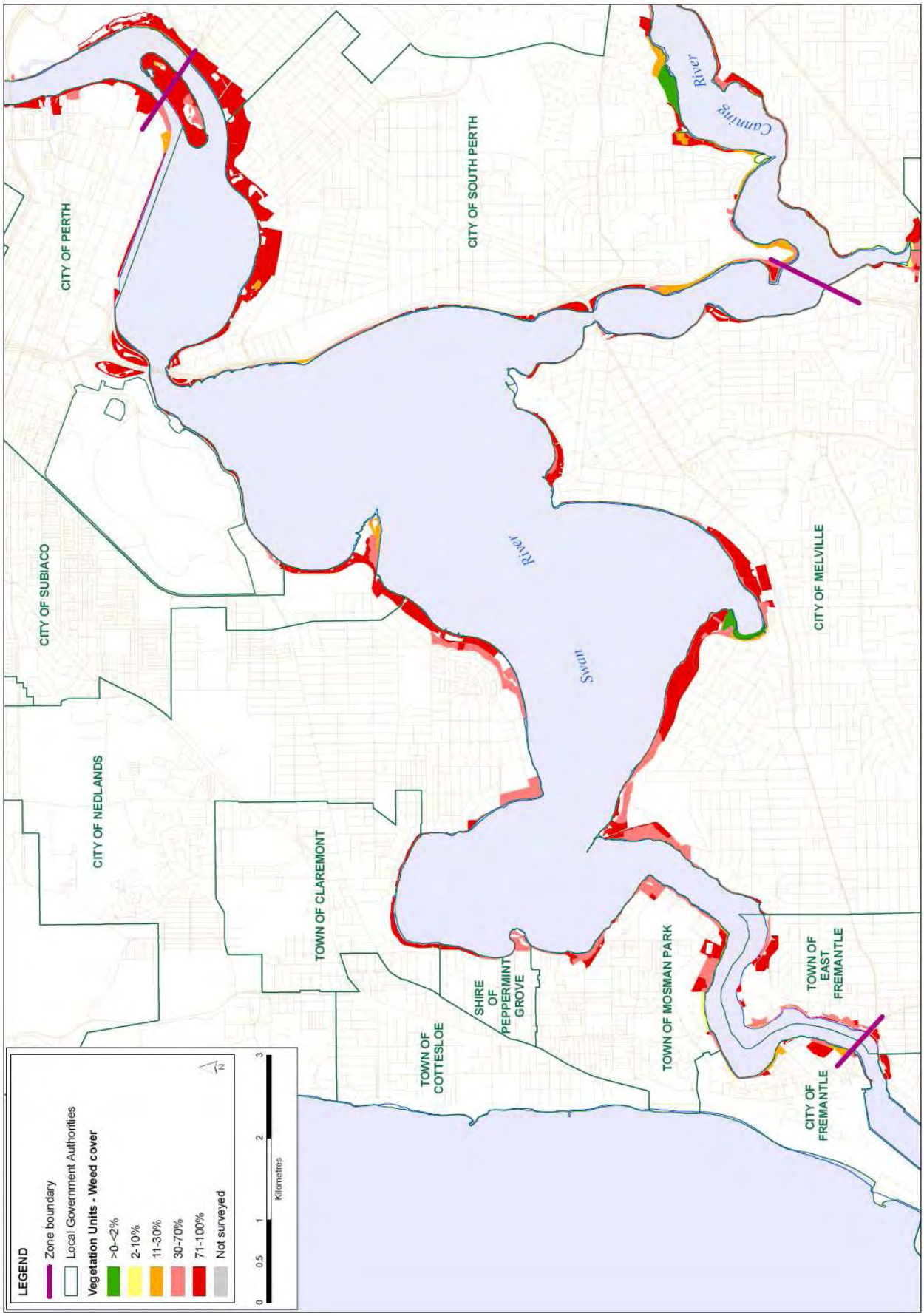


Figure 3.23: Composite weed cover, calculated from all vegetation structural layers along the Estuary Foreshore

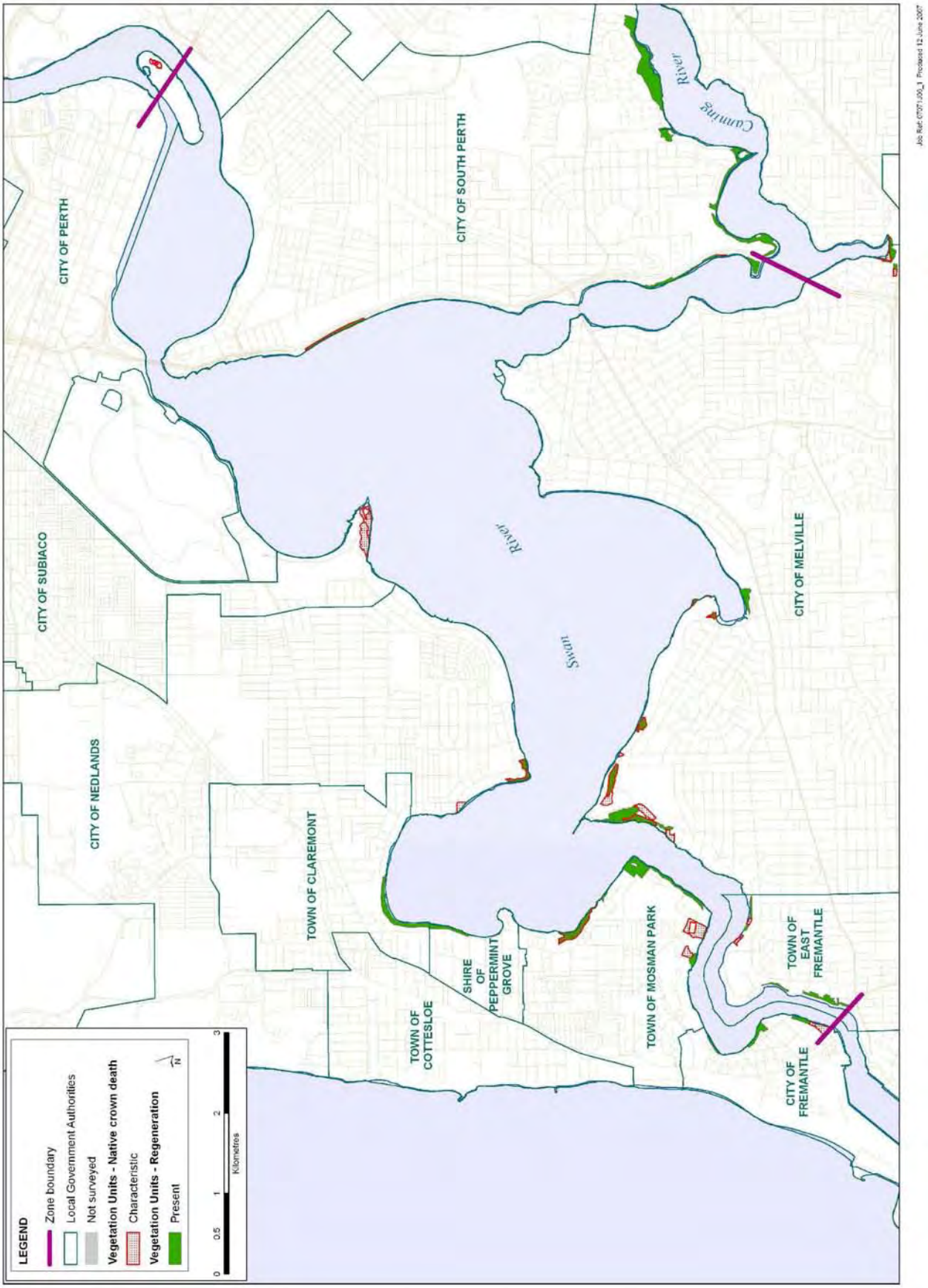


Figure 3.24 Crown death and local species regeneration along the Estuary Foreshore

3.3.3.2 Swan Foreshore (Zone 2)

Overall

Only 15 per cent of vegetation was considered in good condition along the Swan, with 58 per cent considered to be moderate and 27 per cent poor condition (Figure 3.25, Figure 3.26; Appendix 10).

Sedgelands and samphire

In the 77 ha where sedgelands occurred (6 per cent of total area) as the dominant vegetation type, 79 per cent was rated in good condition and 21 per cent as moderate.

Low-lying areas prone to tidal inundation and high salinity have been less disturbed in the mid Swan than for the estuary and continue to support samphire sp *Halosarcia* and *Sarcocornia* which tolerate the stressful saltmarsh environment. Of the 86 ha that occur in the Swan, 65 per cent is in good and 35 per cent in moderate condition.

Regionally significant vegetation

Nine areas were identified as conservation reserves or Bush Forever sites within the Swan (Table 3.36). The majority of these areas are in moderate to good condition, with only 10 per cent of the total area identified as being in poor condition.

Table 3.36 Condition of regionally significant vegetation along the Swan Foreshore

DEC Managed Conservation Reserve					
Identifier	**Location description**	**Good (ha)**	**Moderate (ha)**	**Poor (ha)**	**Total (ha)**
(2065)	Walyunga National Park	3.5	77.0	0.2	80.8
(30192)	Avon Valley National Park		21.95		21.95
Perth Bush Forever sites					
Identifier	Location description	Good (ha)	Moderate (ha)	Poor (ha)	Total (ha)
(BF 214)	Ashfield Flats, Bassendean / Ashfield	18.1	13.4	6.3	37.7
(BF 215)	Helena River, Helena Valley	1.4	5.8	0.0	7.2
(BF 302)	Swan River and Jane Brook, Ashfield to upper Swan	6.8	82.8	4.8	94.4
(BF 305)	Bennett Brook, Eden Hill to West Swan	22.4	11.3	3.9	37.6
(BF 313)	Swan River saltmarshes, Bayswater / Maylands	29.0	7.8	6.6	43.4
(BF 314)	Swan River Foreshore, Mount Lawley / Maylands	10.2	5.1	9.0	24.3
(BF 491)	Swan River Backwater, South Guildford	5.7	4.3	1.5	11.5

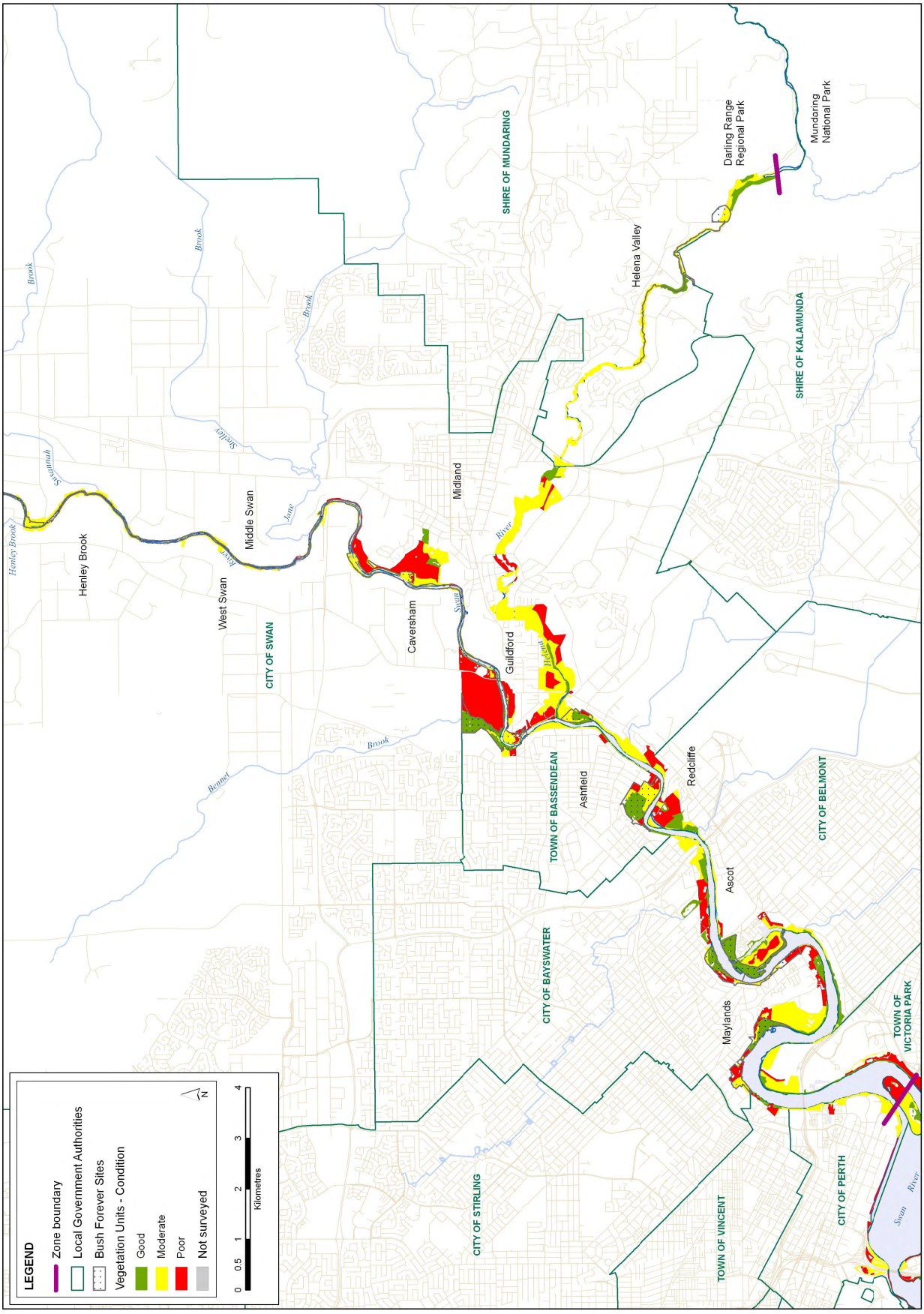


Figure 3.25 Summary of vegetation condition along the lower Swan Foreshore

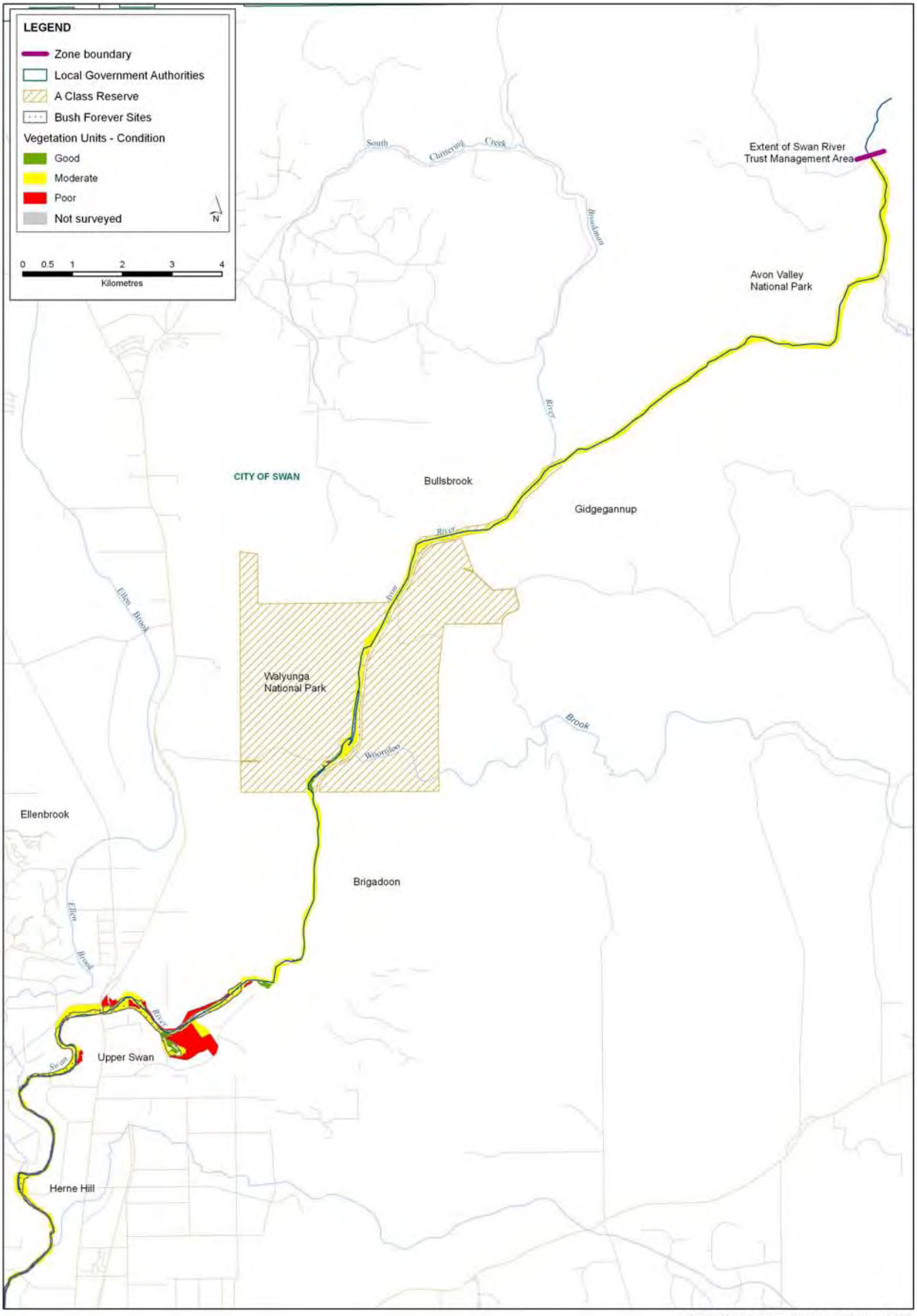


Figure 3.26 Summary of vegetation condition along the upper Swan Foreshore

Degrading factors

Invasive species

Large areas of foreshore along the Swan exhibited high levels of weed cover (71-100 per cent weeds over 644 ha; 31-70 per cent weeds over 609 ha) (Figure 3.27 and Figure 3.28). Only 1.3 ha could be considered weed free. The four most dominant invasive species were Watsonia (*W. meriana*), Typha (*T. orientalis*), Soursob (*O. prescaprae*) and Veldt grass (*E. calycina*).

Diminished regeneration and crown death

Abundant or common recordings of natural regeneration of tree species were limited in the Swan to 24 ha and 248 ha respectively. Approximately 60 per cent of areas showed occasional regeneration and 18 per cent of areas (227 ha) showed no natural regeneration. Similar patterns were found for shrub species (Figure 3.29 and Figure 3.30).

Crown death was recorded across roughly 5 per cent of the areas where trees and shrubs were recorded as structural layers.

Inadequate management

Evidence of disturbance to vegetation from external influences was regularly recorded as being characteristic of vegetation units within the Swan. The most significant for the Swan, affecting over 911.6 ha (65 per cent), was the lack of delineation between areas of exotic grass and native vegetation. The lack of control of grass species poses a considerable threat to vegetation condition, given the invasive potential and ability to smother native species such as sedges, herbs and low shrubs.

The presence of mature trees often coincided with areas where grass was being maintained. The mowing of grass to the base of trees is considered an important factor limiting natural regeneration and was observed across 339 ha. Regeneration of trees and shrubs is also likely to be affected, to some extent, by the regular occurrence of understorey trampling, disturbance around plant roots and domestic animal grazing. These degrading factors were recorded across 200 ha, 172.7 ha and 171.2 ha respectively (Table 3.38).

Table 3.37 Top five management influences on vegetation along the Swan Foreshore

Management influence on vegetation	Area (ha)	% Swan
Mowed grass beneath established trees	911.6	64.8
No delineation between lawn and vegetation	339.0	24.1
Non-local indigenous species planted	200.0	14.2
Trampled understorey	172.7	12.3
Dumped rubbish	171.2	12.2

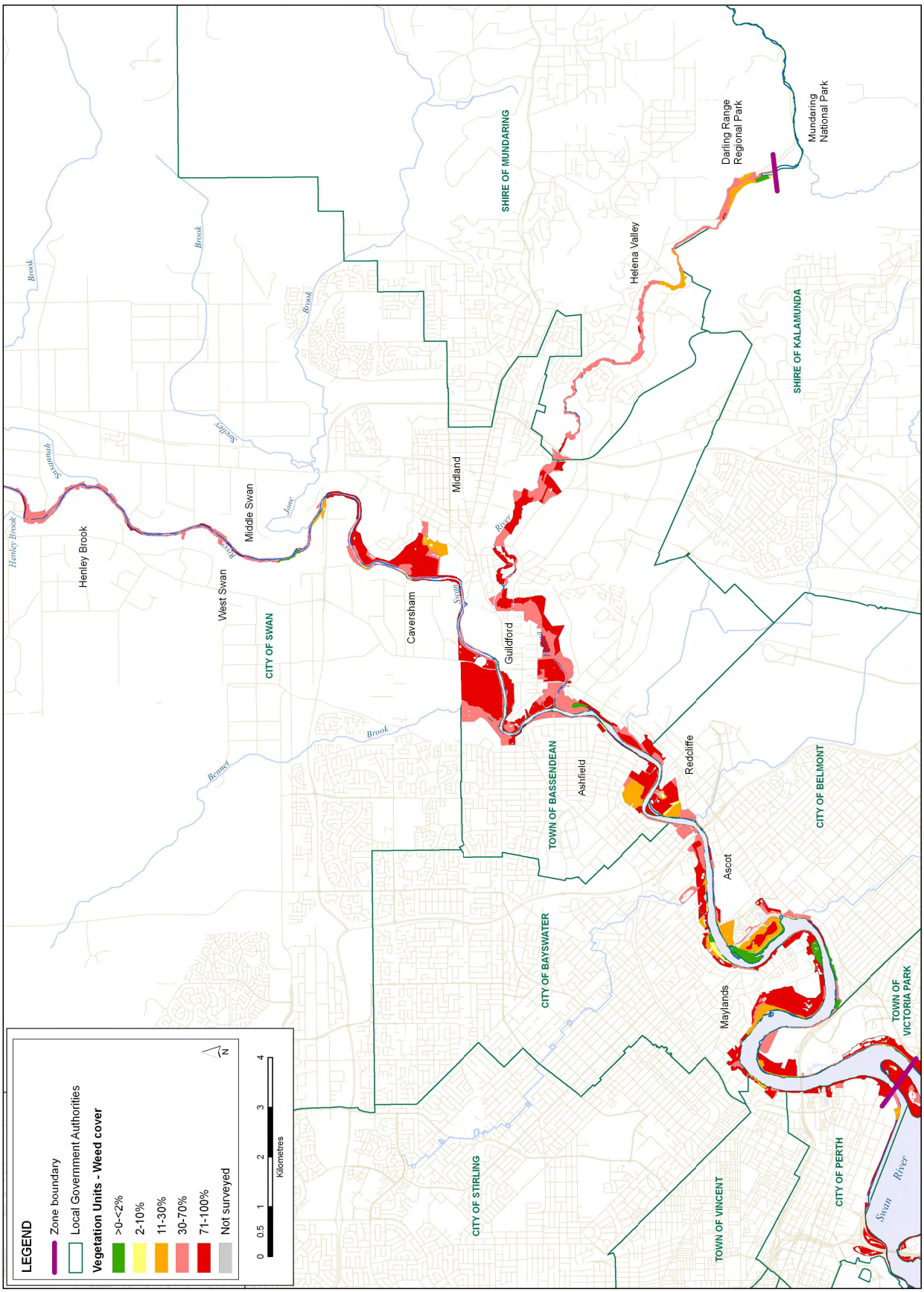


Figure 3.27 Composite weed cover, calculated from all vegetation structural layers along the lower Swan

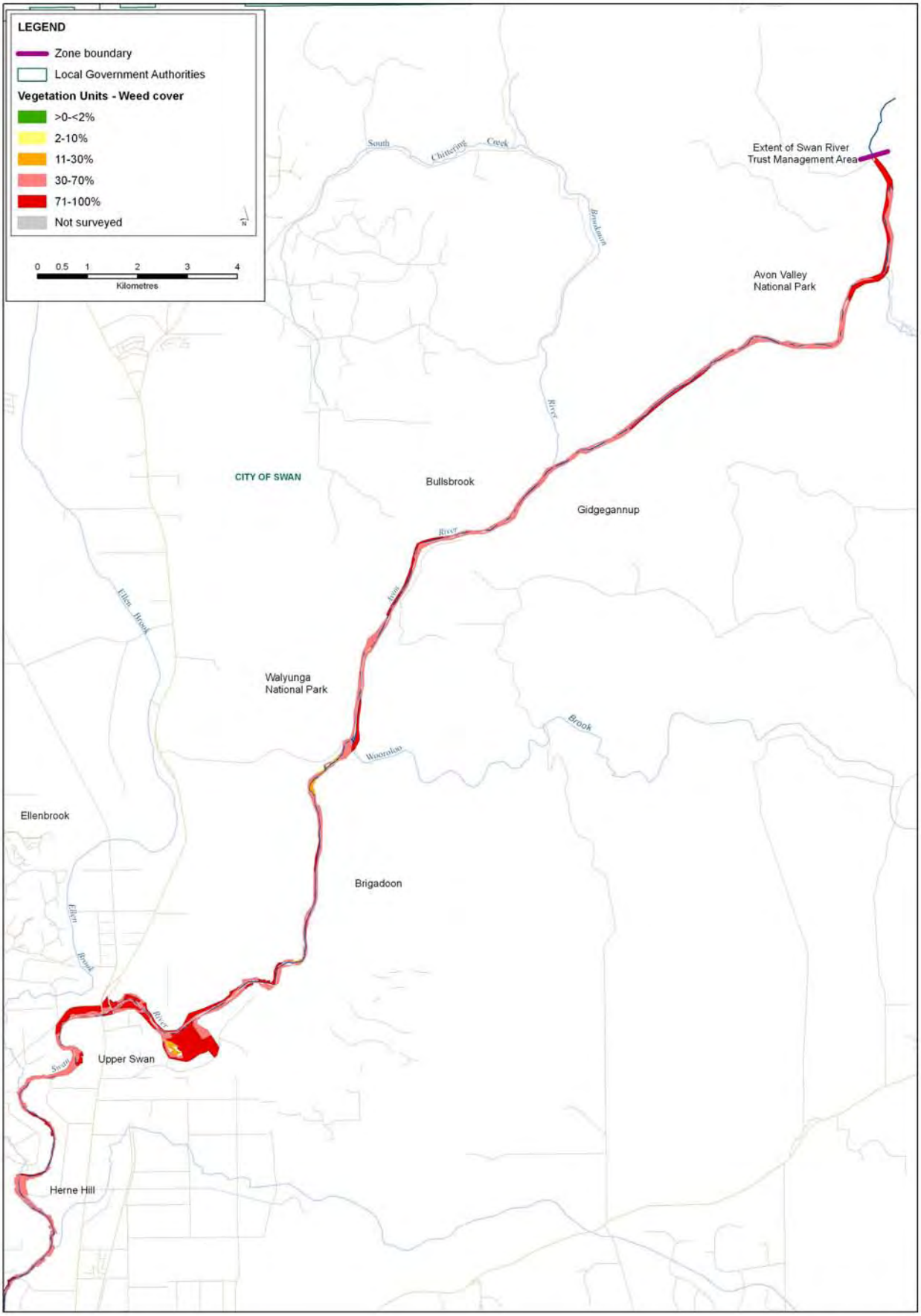


Figure 3.28 Composite weed cover, calculated from all vegetation structural layers, along the upper Swan

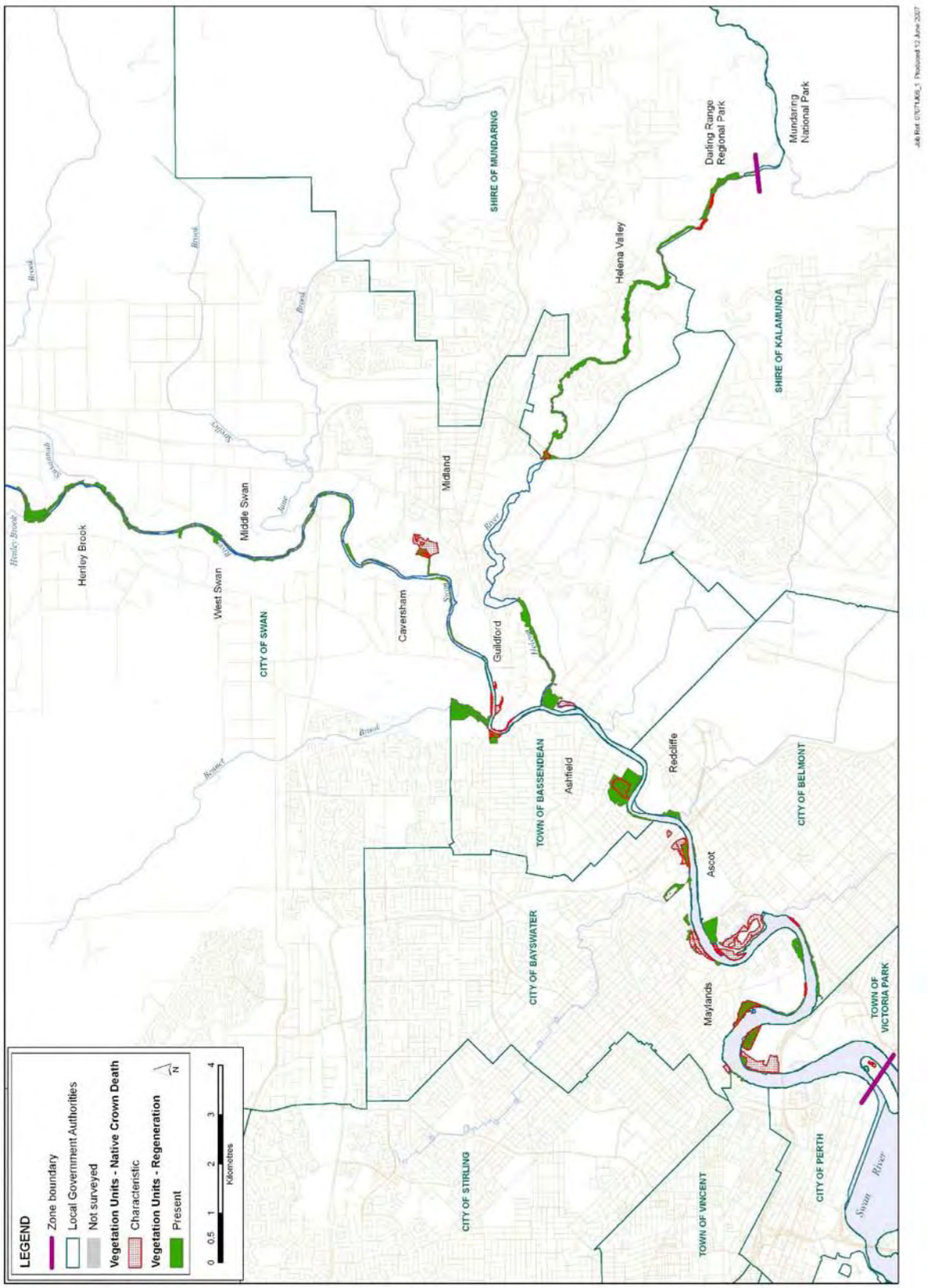


Figure 3.29 Crown death and local species regeneration along the lower Swan

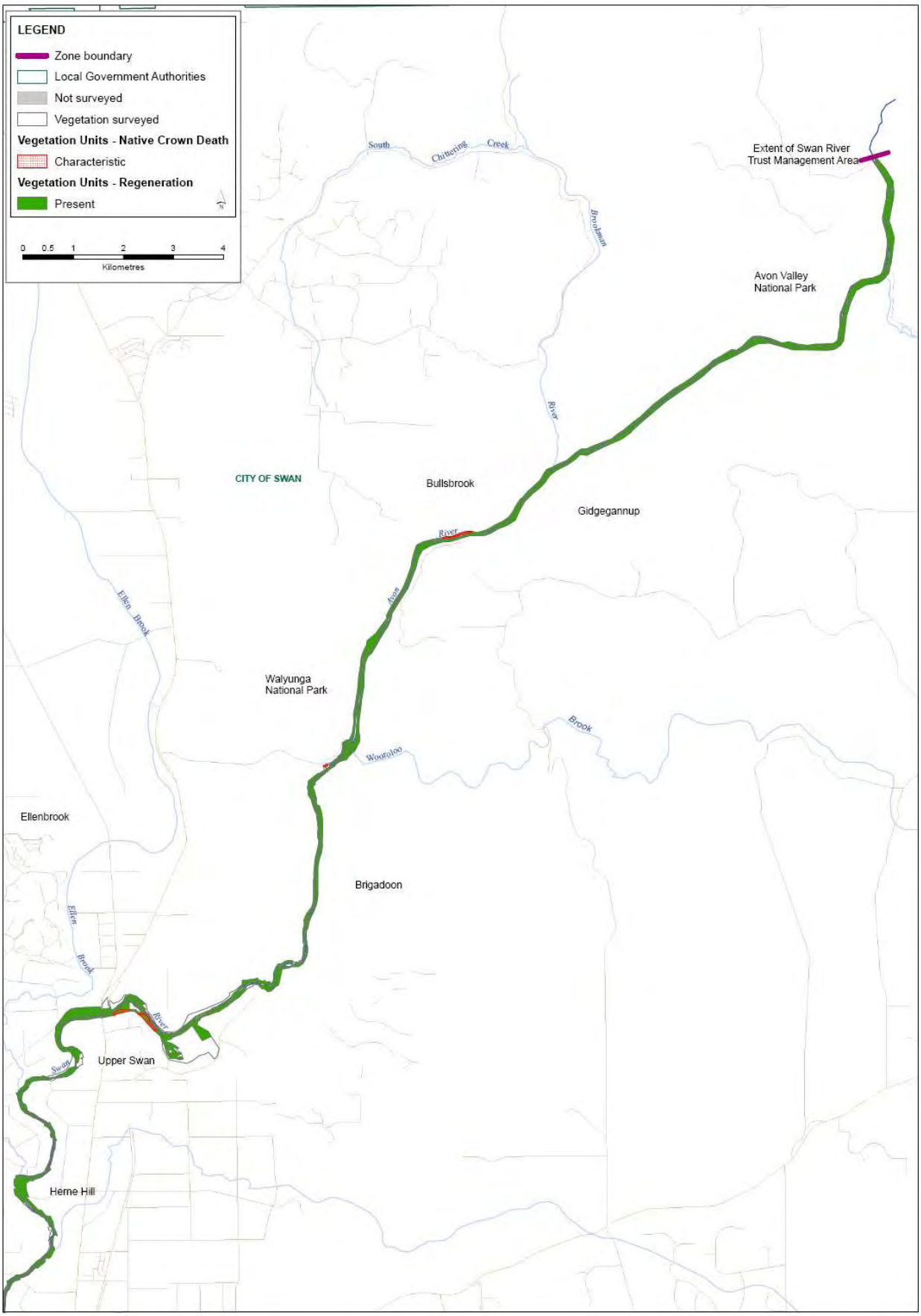


Figure 3.30 Crown death and local species regeneration along the upper Swan

3.3.3.3 Canning Foreshore (Zone 3)

Overall

Around 30 per cent of vegetation along the Canning was considered in good condition, with 39 per cent considered to be moderate and 30 per cent in poor condition (Figure 3.31; Appendix 10).

Sedgelands and samphire

Sedges featured as the dominant structural layer over 44.3 ha of the Canning Foreshore. In total, 43.9 ha of sedge dominated vegetation was rated to be in good condition, while the remaining 0.4 ha was moderate.

Low-lying areas prone to tidal inundation and high salinity are less common along the Canning River where the Kent Street Weir blocks salt-water intrusion upstream in summer and limits the extent of estuarine influence. However, below and in the immediate vicinity of the weir, areas of foreshore continue to support native samphire shrub *Halosarcia* and *Sarcocornia* sp. In total, 21.5 ha of samphire was recorded and all this was in good condition.

Regionally significant conservation value foreshore

Along the Canning, large areas of regionally significant foreshore vegetation are degraded, with 68 per cent of these areas being moderate to poor condition (Table 3.38). This is particularly true for the Canning and Southern rivers between Beckenham and Kelmscott, as well as areas within the Canning River Regional Park and adjacent bushland.

Table 3.38 Condition of regionally significant vegetation along Zone 3

Perth Bush Forever Sites						
Identifier	**Location Description**	**Good (ha)**	**Moderate (ha)**	**Poor (ha)**	**Unassessed (ha)**	**Total (ha)**
(BF 224)	Canning River Regional Park and adjacent bushland, Riverton to Langford	118.9	92.8	91.3	16.0	319.1
(BF 227)	Mount Henry Bushland, Salter Point	2.1	1.2	0.1		3.4
(BF 246)	Canning and Southern Rivers, Beckenham to Martin / Kelmscott	48.6	138.6	105.6		292.8
(BF 255)	Dallen Road Bushland, Southern River / Gosnells	0.6	6.5	0.3		7.3
(BF 333)	Canning River foreshore (Salter Point to Wilson, Clontarf)	20.9	0.8	4.3		26.0
(BF 338)	Yagan Wetland and adjacent bushland, Rossmoyne to Bull Creek	2.2	6.9	0.4		9.5

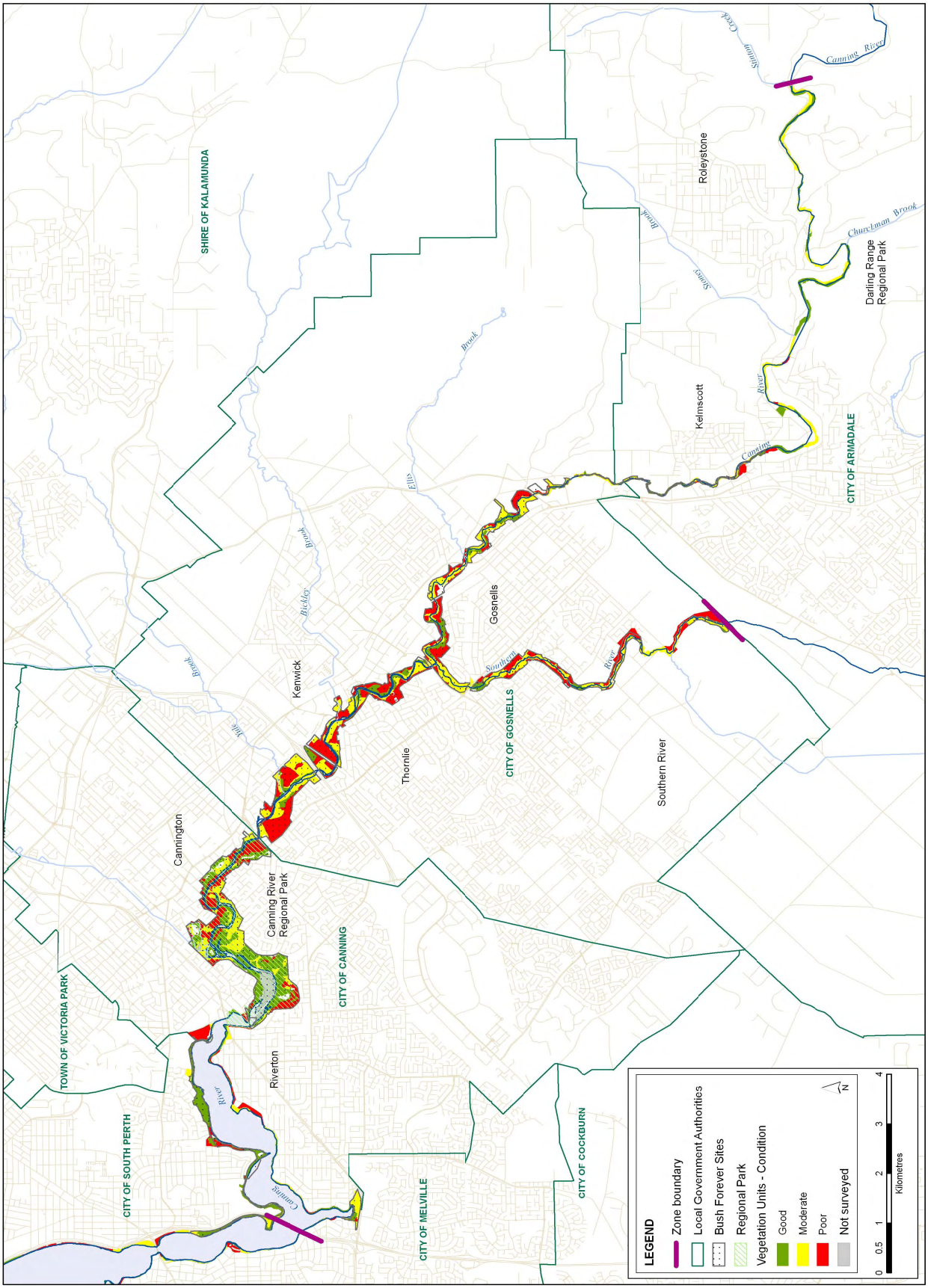


Figure 3.31 Summary of vegetation condition along the Canning

Degrading factors

Invasive species

Along the Canning, there was a strong trend toward weed invasion and displacement of native vegetation. Approximately 345.3 ha (41 per cent) of foreshore along the Canning had weed cover in excess of 71 per cent, while an almost equal area of foreshore had weed cover of 31-70 per cent. Only 48.2 ha (6 per cent) could be considered relatively weed free, with less than 10 per cent weed cover (Figure 3.32).

The four most common weed species were Blackberry (*Rubus spp*), Watsonia (*W. meraina*), Soursob (*O. pes-caprae*) and Veldt grass (*E. calycina*).

Diminished natural regeneration and crown death

In contrast to the Swan and Estuary foreshores, regeneration of tree species was common in the Canning. Only 14 per cent of area recorded no regeneration. However, regeneration was still rarely abundant, with most areas (55 per cent) showing only occasional regeneration. Similar patterns were observed for shrub species. Crown death was an uncommon occurrence in the Canning (Figure 3.33).

Inadequate management

Evidence of disturbance to vegetation from external influences was characteristic of vegetation units along the Canning. The most significant, affecting over 626.3 ha (74 per cent), was the lack of delineation between areas of exotic grass and native vegetation. The lack of control of grass species poses a considerable threat to vegetation condition, given the invasive potential and ability to smother native species such as sedges, herbs and low shrubs (Table 3.39). The presence of mature trees often coincided with areas where grass was being maintained. The mowing of grass to the base of trees is considered an important factor limiting natural regeneration and was observed across 185.8 ha.

Evidence of domestic animal grazing and fire were recorded within 71.4 ha and 66.4 ha respectively. The next most common management issues were rubbish dumping recorded within 49.3 ha, and understorey trampling across 27.5 ha.

Table 3.39 Top five management influences on vegetation along the Canning

Management Influence on Vegetation	Area (ha)	% Canning
Mowed grass beneath established trees	626.3	74.1
No delineation between lawn and vegetation	185.8	22.0
Non-local indigenous species planted	71.4	8.4
Trampled understorey	66.4	7.9
Dumped rubbish	49.3	5.8

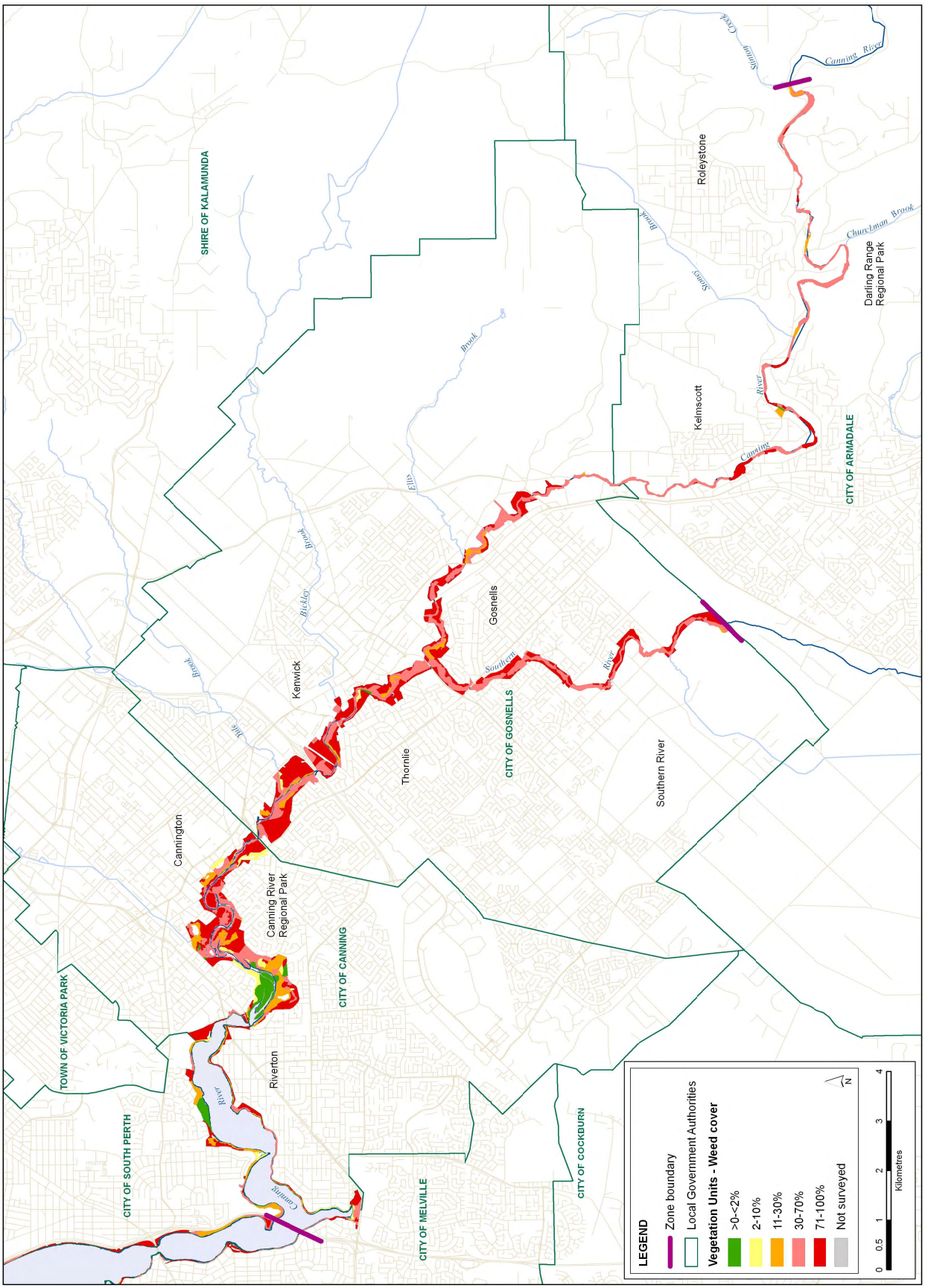


Figure 3.32 Composite weed cover, calculated from all vegetation structural layers, along the Canning Foreshore

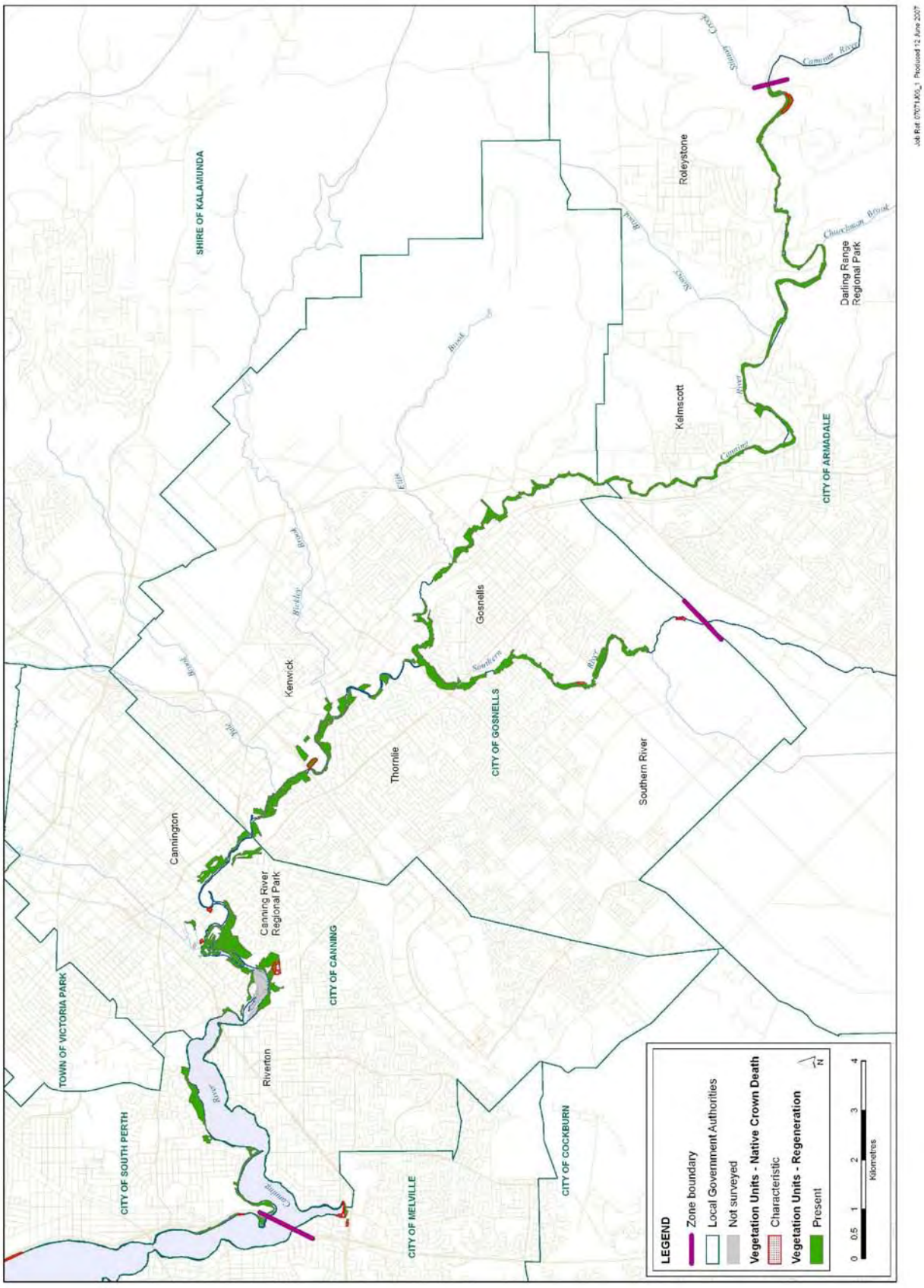


Figure 3.33 Crown death and local species regeneration along the Canning Foreshore

4 Foreshore Strategy

4.1 Approach

The Foreshore Assessment (refer to section 3) described the Swan and Canning river foreshores, their pressures and condition. That information formed the basis of this strategy and was used to identify issues to define management responses and to set priorities for action.

The strategy has two overarching objectives that are consistent with the River*bank* Program.

- To protect and enhance riverbanks and shorelines to mitigate threats to foreshore values; and
- To protect, enhance and manage fringing indigenous vegetation and habitat.

Within the first objective, the term 'shoreline' is defined as the area two metres either side of the high water mark (*Swan Canning Rivers Management Act 2006*). This is used in combination with the term 'riverbank' to acknowledge the spatial extent of foreshores and their values.

In keeping with these two objectives and the approach of the foreshore assessment, the strategy considers the riverbanks and shorelines separately from vegetation.

4.1.1 Overall approach to prioritisation

In considering priorities for management and investment, the Trust has adopted the stream restoration principles (Rutherford *et al.* 2000) including:

- preserve what is good, before trying to fix what is bad;
- work on reaches and problems in the following order: rare reaches before common ones; good condition before bad; deteriorating reaches before stable or improving; and easy reaches to fix before hard;
- recognise intractable reaches for what they are, and spend effort on other reaches where there is more chance of success;
- within a reach, fix fatal problems first; and
- identify links between problems in a reach.

Therefore, the identified priorities account for factors such as value, condition and the potential for deterioration or threat. These factors are considered differently for the two objectives (Table 4.1). For riverbanks and shorelines, adjacent infrastructure, recreational amenity (including parklands) and environmental values are considered in determining priorities. To set priorities for fringing vegetation and habitat, the environmental values – conservation and biodiversity – are given precedence. The approach to prioritisation against the two objectives is described in more detail in sections 4.3.1 and 4.5.1

Table 4.1 Factors considered in prioritising foreshore management action

Vegetation and Habitat	Riverbanks and Shorelines
Conservation and biodiversity value	Proximity of foreshore to infrastructure, recreational amenity or environmental value.
Condition (good / moderate / poor)	Condition of the foreshore or built structure (good / moderate / poor).
Potential for deterioration • invasive weeds • degrading factors • eroding shoreline	Potential for value to be threatened as a result of erosion, inundation and / or sedimentation.

4.2 Riverbanks and Shoreline Issues and Management

4.2.1 Issues

There were four main issues observed for riverbanks and shorelines across the Swan Canning system:

1. Inadequate foreshore setback: when development occurs too close to the river in areas where the bank is highly susceptible to external loads such as river flow or inundation;
2. Inadequate natural stability: when bank structure is reliant on small internal features, particularly those susceptible to change, such as a bank maintained by tree roots;
3. Disturbance of sediment transport patterns: susceptibility to external changes in sediment transport and sediment supply; and
4. Inadequate structural stability: the performance of engineered structures (type, condition and function) to ensure ongoing foreshore stability. This is anticipated to be a less significant problem in the Swan and Canning than in the estuary as there is a smaller area of reclaimed foreshores.

The issues facing each zone are discussed in more detail in the sections below.

4.2.1.1 Estuary (Zone 1)

Vegetated shores in high energy locations along the estuary may require management to mitigate erosion at some stage in the future (Table 3.13). The most critical location of those identified is at Como Beach N, which has a high level of exposure. Bioengineering techniques may be considered for those locations with wave climate less than 0.8 m, but these have limited capacity in locations experiencing ongoing erosion (Table 4.2).

Table 4.2 Possible management for high energy vegetated shores

Location	Possible Management
Como Beach N	Managed retreat; renourishment
Scout Hall	Managed retreat; renourishment
Tompkins Park N	Managed retreat
Alfred Cove E	Bioengineering; renourishment
Salter Point W	Bioengineering; traffic control; renourishment
Rossmoyne W	Bioengineering; traffic control; renourishment
Shelley E	Bioengineering; traffic control; renourishment
Mount Henry W	Managed retreat; renourishment
Cloisters S	Managed retreat; renourishment
Shelley Water	Managed retreat; renourishment

Mobile sedimentary shore movements are likely to be less than 20 m, which is acceptable where infrastructure is sufficiently set back from the shore. The foreshore setback suggested by Western Australian planning guidelines provides sufficient capacity to allow for natural foreshore movements in the Estuary (WAPC 1989; 2003).

Management of mobile sedimentary shores is normally conducted without haste, as they have a strong capacity for recovery following any erosive event. However, this is inappropriate where the erosion is progressive, such as identified at Como Foreshore and Waylen Bay. Management options include managed migration, or ongoing renourishment. Foreshore protection measures, such as riverwalling, will typically transfer the problem further along the shore.

All built structures need periodic monitoring and maintenance when appropriate. Recommended works for built structures in specific locations along the Estuary are shown in Appendix 7. Structures with poor function and condition should be assessed with a view to removing and replacing as appropriate.

Some areas of foreshore are more prone to inundation than others. Where infrastructure is at risk, mitigation approaches may be necessary. However, techniques to mitigate inundation can be costly, affect foreshore amenity and have ongoing management requirements (Appendix 8).

4.2.1.2 Swan (Zone 2)

The main foreshore problems along the Swan are related to natural stability, with disturbance of sediment transport patterns anticipated to increase in significance in the future due to excess sediment progressing down the Avon River. The inadequate natural stability is mainly due to an insufficient width of vegetation. If revegetation or sediment management plans are not implemented, it is anticipated that the vegetation will continue to collapse until the shore is no longer maintained by trees and / or sedges. This will result in exacerbated bank migration and erosion. The resultant sediment migrating down the Avon River will lead to increased sedimentation downstream of the scarp, with the potential for the channel planform to switch to braided and anastomosed further downstream as the sediment supply increases.

Strategies relevant for management of these shoreline issues are outlined in Table 4.3.

4.2.1.3 Canning (Zone 3)

The main foreshore problem along the Canning is related to disturbance of sediment transport patterns through flow regulation due to dam creation for metropolitan water supply. There is insufficient flow to scour the river of sediment, with enhanced sediment inputs from tributary modification and sediment entering from drains resulting in widespread sedimentation. Clearing of vegetation and opportunistic replacement by weed encroachment has reduced the natural stability of the banks. If the ambient flow is not increased, sedimentation will result in decreased channel cross-sectional areas, and consequent increase in inundation levels and changing flow patterns. This will increase the likelihood of bank migration and fluctuations of the channel location.

Strategies relevant for management of these shoreline issues are outlined in Table 4.3.

4.2.2 Management strategies

General strategies for management of the four main issues facing the shorelines include:

- managed migration;
- monitoring and maintenance of structures;
- use of revegetation, bioengineering and renourishment as a preference prior to hard structures;
- reducing sediment entering the river; and
- use of mitigation structures when retreat and soft engineering solutions are not an option.

Management strategies have been identified for each issue, and Table 4.3 shows the areas to which these are relevant. A level of priority (high and lower) to engineering works to target funding allocation has been used within some of the strategies.

Table 4.3 Management strategies to protect and enhance the riverbanks and shorelines to mitigate threats to foreshore values

Issue	Management strategy	Estuary locations	Swan locations	Canning locations
Inadequate foreshore setback	**A:** Managed migration. Where appropriate, allow natural erosion processes to occur (i.e.: outside meander bends and mobile sedimentary shores). This may require removal of some infrastructure and restricting public access.	Alfred Cove to South Lucky Bay (S.13).	Causeway to Claisebrook (West S.26); Tranby North (S.34); Ashfield Parade (S.37); Lilac Hill (S.43); Success Hill (S.46); Bells Rapids Park (S.54) and most areas upstream of Middle Swan Bridge (excluding bridges).	Canning River Regional Park and most areas upstream of Djarlgarra Bridge (Roe Highway S.67) are not used for navigation (excluding bridge abutments).
	B: Ensure future developments have sufficient foreshore setback to allow for inundation and channel planform / bank migration.	**ALL**	**ALL**	**ALL**
	C: Address the likelihood of increased flooding and inundation in prone areas.	**High:** Como Beach (Kwinana Freeway S.21-S.22); Mounts Bay Road (S.8); Esplanade (Perth S.10). **Lower:** Claremont-Nedlands foreshore (S.4-S.6); Waylen Bay (S.16); South Perth foreshore from Mends Street to Causeway (S.24).	**Lower:** Boat ramps at Maylands Peninsula (S.31); Katanning Street (Ashfield S.36); Pickering Park (Bassendean S.39); and Fish Market Reserve (S.42). Also the Esplanade (Ascot upstream of S.35); Rowing Club at AP Hinds Reserve (opposite S.35).	
	D: Undertake renourishment where appropriate.	**High:** Como Beach (Kwinana Freeway S.21-S.22); Coffee Point to Canning Bridge (S.18). **Lower:** Barrack Square West (S.9); some areas of the Esplanade (Mount Pleasant S.19); Southern Matilda Bay (S.7).	**Lower:** Locations within Causeway to Claisebrook (East and West S.26-S.27); Balbuk Way (S.30); Claughton Reserve (S.36); Garvey Park (S.37); Sandy Beach Reserve (S.38); Woodbridge Riverside Park (S.47).	**Lower:** Mount Henry (West S.55); Bull Creek (West S.60); locations within Shelley-Rossmoyne foreshore (S.61); Shelley Bridge to Riverton Bridge (West S.62).
	E: Where valuable infrastructure or recreational amenity is threatened by erosion and renourishment is not an option, consider appropriate stabilisation works, including bioengineering.	Point Walter (S.11); some areas of the Esplanade (Mount Pleasant, S.19); Lucky Bay (S.14); Mount Henry Bridge to Canning Bridge (East S.20).	Balbuk Way (S.30); Tranby (S.34); Garvey Park (S.37); St Vincent's Hospital (S.44); Midland Brick (S.49).	Locations within Shelley water (S.57-S.61) including Rossmoyne W; Shelley Beach; Curtin Rowing Club W; near Modollion Ave N; Wadjup Point E; Riverton Drive East; Waterford Sea Scout / Naval Cadets; and Riverton Jetty Park (S.62).
Inadequate natural stability	**F:** Prepare a foreshore revegetation plan to widen vegetation buffer. Use bioengineering where appropriate. Ensure foreshore is stabilised when weeds are removed.	Point Walter to South Lucky Bay (S.12-S.13); Mount Henry Bridge to Canning Bridge (East S.20).	Causeway to Susannah Brook confluence with key locations identified in Table 4.5, mainly focused on reserve locations.	Locations within Riverton-Shelley (S.61); Salter Point (S.56-S.57); Bull Creek (West S.69); Shelley Bridge to Riverton Bridge (S.62); Masons Landing Park (S.64); Hester Park (S.65).

Issue	Management strategy	Estuary locations	Swan locations	Canning locations
Inadequate natural stability	**G***:* Manage recreation use areas by providing controlled pedestrian access, fishing platforms and minimise impact of boat launching and landing control.	Point Walter (S.11); Fremantle to Chidley Point (S.1).	Pedestrian access [reserves downstream of Middle Swan Bridge]; boat / kayak landing [in vicinity of boat ramps and at Trinity School (S.26); Woodbridge (S.47); Reg Bond Reserve (S.48); Middle Swan Bridge (both banks S.50)].	Pedestrian access [Shelley-Rossmoyne and Salter Point]; boat / kayak landing [Shelley Beach and Wadjup Point (S.61); Shelley Bridge to Riverton Bridge (S.62); Kent Street Weir (S.63); Hester Park (S.65)].
	H*:* Fencing to minimise animal trampling with management of introduced pests (i.e. pigs and rabbits).		Upstream of Wooroloo Brook (pigs); Localised areas require fencing in Geomorphic Units 3-6.	Southern River (Geomorphic Unit 5) had localised areas of rabbit activity.
Disturbance of sediment transport patterns	**I***:* Investigate measures to reduce sedimentation, including increased river flow through dam release, review of private abstraction licences to ensure sufficient environmental flows, sediment extraction or removal of artificial barriers to flow.			Between Bickley Brook and the scarp along both the Canning and Southern rivers (S.67).
	J*:* Reduce sediment input to the system through a comprehensive sediment management plan.		Between Henley Brook and Bells Rapids.	Shelley-Rossmoyne (S.61); between Bickley Brook and the scarp along both the Canning and Southern rivers (S.67).
	K*:* Improve control of boating including enforcement of low speed zones and establish low or no wash zones. Continue community awareness and education programs about boat wash.		Causeway to Middle Swan Bridge with focus on eight knot area between downstream end of Goodwood Parade Water Ski Area and Helena River confluence.	
	L*:* Encourage retrofitting of existing drainage structures to incorporate sediment traps and design features to minimise scour. Promote stormwater management plan.	**ALL**	**ALL**	**ALL** (including sediment traps for areas upstream of Bickley Brook-S.36).
Inadequate structural stability	**M***:* Develop plan for monitoring and maintenance of structures, including structures which are no longer functional and could be removed.	**ALL**	**ALL**	**ALL**
	N*:* Identify mechanisms for sourcing funds (including River*bank*) to support maintenance works.	**ALL** **High:** Mounts Bay Road to Point Fraser (S.8-S10); Canning Bridge to Narrows (S.21-S.22); Mend Street to Causeway (S.24). **Lower:** Esplanade (S.19); Lucky Bay (S.14); Coffee Point to Canning Bridge (S.18); Point Resolution to Pelican Point (Nedlands S.5-S.6); Causeway abutments.	**ALL** **Lower:** Bridge abutments and structures adjacent to boat ramps [Balbuk Way (S.30); Pickering Park (S.39) and Fish Market Reserve (S.42)]; Tranby (once reconstructed S.34); Garvey Park (S.37).	**ALL** **Lower:** Bridge abutments with focus on Roe Highway (S.66) and Ferres Drive (S.68) as units / sand are being removed.

4.3 Priorities for Action - Riverbanks and Shorelines

4.3.1 Method of prioritisation

All sites (a single or group of reaches) with significant infrastructure, recreational amenity or environmental values close to a foreshore that is eroding, migrating or susceptible to inundation are considered to be a priority for management. These were assessed further to establish their relative importance.

A priority ranking (1 - high; 2 - medium; 3 - low) was assigned to sites based on a review of three elements: value, condition and threat. These three elements are described below:

Human value (value)
Human values allocated to the foreshore for the purpose of ranking include:

- Infrastructure – roads, bridges, buildings (including foundations), car parks and boat ramps. This includes a consideration of public safety;
- Recreational amenity – dual use paths, walking paths, recreational fishing areas, sites of boating activity and / or kayaking, jetties, recreational reserve areas, beaches, park benches and playground equipment. This includes a consideration of public safety; and
- Environmental – wetlands / reserves / banks of environmental significance.

The value ranking increased with proximity to a foreshore susceptible to erosion / inundation. The recreational amenity value increases with the number of recreation uses at the site and the infrastructure value was increased based on the estimated cost of the infrastructure.

Condition of the foreshore (condition)
The condition of the foreshore was assessed separately for built and non-built foreshores. Built foreshore condition was based on the condition rank assigned during the structure assessment (section 3.5). The non-built foreshore condition was ranked based on information collected during the foreshore assessment (state and coverage of stabilising vegetation, evidence of erosion, nature of the bank material and destabilising processes).

Threat to value (threat)
The ranking of threat was determined as the potential for the human value to be threatened by erosion, inundation or foreshore migration. The rank was based on consideration of the active processes described in section 3.1, and the susceptibility of the foreshore to these processes. The assessment of susceptibility included considering the condition, foreshore elevation and channel / estuarine location. If there was a high potential for erosion or inundation and the human value was located in the spatial extent of influence, there was a potential threat.

The ranking of value, condition, threat and priority are presented along with the suggested management strategies to be implemented at each site. More detailed management suggestions are included for Priority 1 sites.

4.3.2 Estuary (Zone 1)

Management priorities are outlined in Table 4.4 and displayed spatially within Figure 4.1. A summary description and management actions for each of the Priority 1 sites is included in the following summary tables Figure 4.1.

Table 4.4 Estuary Zone: Priority areas for management actions aimed at the protection and enhancement the riverbanks and shorelines to mitigate threats to values

Site No.	Location	Value	Condition	Threat	Priority	Strategy No.
S.1	Fremantle to Chidley Point (including reserves such as John Tonkin Park)	High (amenity, infrastructure)	Moderate-Good	Moderate	2	M, D, E , N (lower priority for Stirling Hwy to John Tonkin Park)
Right Bank						
S.2	Chidley Point to Keanes Point	Moderate (amenity, minor infrastructure)	Good	Moderate	3	M, D
S.3	Keanes Point to Claremont Cliffs	Moderate (infrastructure, amenity)	Good	Moderate	3	M
S.4	Claremont Cliffs to Point Resolution	Moderate (infrastructure, amenity)	Good	Moderate	3	C, D
S.5	Point Resolution to Nedlands Foreshore	Moderate (amenity, infrastructure)	Moderate	Moderate	2	E, M, Lower priority for N and C
S.6	Nedlands Foreshore to Pelican Point	High (amenity, infrastructure)	Good	Moderate	2	M, E, D, Lower priority for N and C
S.7	Pelican Point to UWA Boat Club (Matilda Bay)	Moderate (amenity, infrastructure)	Good	Moderate	3	B, E, D, C
S.8	UWA Boat Club to Narrows	High (infrastructure, amenity)	Poor-Good	High	1	N, M, C
S.9	Narrows to Barrack Square	High (infrastructure, amenity)	Moderate	High	1	D, N, M, C
S.10	Barrack Square to Point Fraser	High (infrastructure, amenity)	Moderate	High	1	N, M, C
Left Bank						
S.11	Point Walter Reserve (end of Blackwall Reach Parade to Stock Road)	High (infrastructure, amenity)	Moderate	High	1	D, E, B, M
S.12	Point Walter to Alfred Cove	Moderate (amenity)	Moderate-Good	Moderate	3	E

Site No.	Location	Value	Condition	Threat	Priority	Strategy No.
Left Bank continued						
S.13	Alfred Cove to South Lucky Bay (Cunningham Street)	Moderate (amenity, environment)	Good	Low	3	C, A, B
S.14	South Lucky Bay (Cunningham Street) to Point Dundas	High (infrastructure, amenity)	Moderate	Moderate	2	M, E (linear defences), N (lower priority)
S.15	Point Dundas to Applecross Jetty	Moderate (infrastructure, amenity)	Moderate	Low	3	D, M
S.16	Applecross Jetty to Point Heathcote	Moderate (infrastructure, amenity)	Moderate	High	2	D, E, C
S.17	Point Heathcote to Coffee Point	Moderate (private infrastructure)	Good	Low	3	Dredging
S.18	Coffee Point to Canning Bridge	Moderate (infrastructure, amenity)	Moderate	High	2	C, M, D, N (lower priority)
S.19	Canning Bridge to Mount Henry Bridge (W)	High (infrastructure, amenity)	Poor-Moderate	Moderate	2	D, E, L, M, ;lower priority for N and C
S.20	Mount Henry Bridge (E) to Canning Bridge	Moderate (infrastructure, amenity, environmental)	Moderate	Moderate	2	E, F, M
S.21	Como Foreshore [1. Cassey Street to Scout Hall and 2. Cale Street to Richardson Street]	High (infrastructure, amenity)	Poor-Moderate	High	1	D, C, M, N
S.22	Richardson Street to N end of Narrows PWC area	High (infrastructure, amenity)	Moderate	High	1	D, C, E, M, N
S.23	N end of Narrows PWC area to Mends Street (including Narrows)	Moderate (infrastructure, amenity)	Moderate	Moderate	2	M, D
S.24	Mends Street to Causeway	High (infrastructure, amenity)	Moderate	Moderate	2	N, M

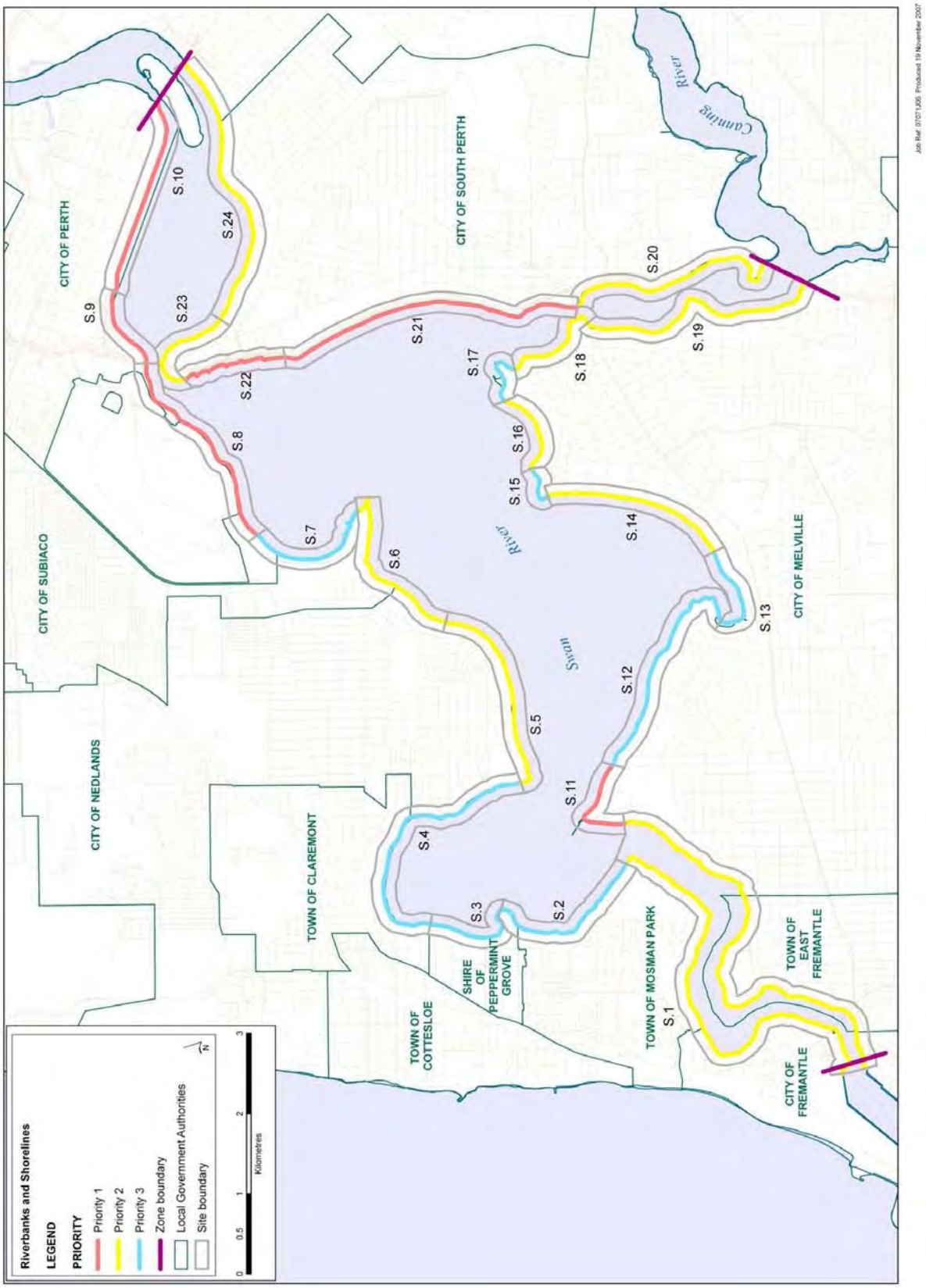


Figure 4.1 Estuary Zone: priority areas for management action aimed at protecting and enhancing the riverbanks and shorelines to mitigate threats to values

Mounts Bay Road / Esplanade Walling: UWA Boat Club to Narrows to Point Fraser (Sites S.8–S.10)

Priority 1

Description: This length of shore is intensively walled and is wholly artificial due to reclamation works. Shore protection types vary from vertical walls to inclined gabion baskets. The walling between the UWA Boat Club and approaching the Narrows from the west sustains the location of Mounts Bay Road, a dual use path and the Brewery site. Stresses acting on the walling vary along its length with localised bed movements and occasional wave overtopping. Some sections of walling are in disrepair due to installation of inadequate structures.

A reclaimed beach was constructed west of Barrack Square. This beach has eroded in recent years, possibly associated with flow through the Narrows Channel.

The low elevation walling adjacent to the Esplanade (east of Barrack Square) is susceptible to inundation during coastal flooding, river flooding and severe southerly storms.

Inundation across this wider area may cause damage to infrastructure and may occasionally compromise public and traffic safety.

Shore type: Built structure is dominant with a small section of beach west of Barrack Square.

Length: Approximately 6.5 km.

Vested authority (s): City of Perth, City of Subiaco.

Management strategies: N (source funds for structural maintenance work), M (structural monitoring and maintenance plan), C (address potential for increased flooding and inundation in prone areas) and D (renourishment) for the beach west of Barrack Square. However, the relocation of roads during the train line construction in the vicinity of the beach may have allowed sufficient space for managed retreat.

Management recommendations:

Undertake works to address gabion failure along Mounts Bay Road.

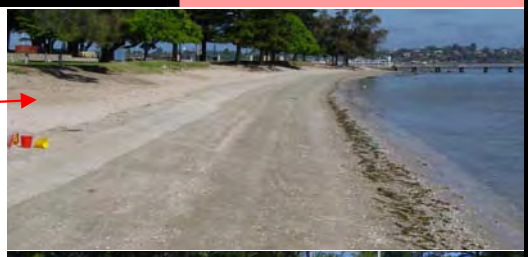
Develop a monitoring plan to identify when structures require works as part of a fast-track application for maintenance funding (e.g. River*bank*). The structure may need deeper embedding in certain locations (e.g. west of the Narrows).

Develop an inundation plan including investigating a viable management solution (Appendix 8) as many areas of walling are low-lying with dual use paths and roads behind the walling.

Renourish the beach west of Barrack Square with monitoring and an ongoing renourishment plan including risk of inundation.

Point Walter Reserve, Bicton (Site S.11)

Priority 1



Description: Point Walter is characterised by a large sand spit adjacent to the tidal channel between Fremantle and Freshwater Bay. Historically, dredging has occurred in the basin adjacent to the Point Walter jetty.

The impervious nature of the Point Walter jetty exacerbates erosion problems of the foreshore immediately east of the jetty. Other impermeable structures, particularly the two Point Walter boat ramps, are subject to updrift accretion and downdrift erosion, which may reverse direction seasonally.

This erosion is a concern due to the high level of recreation use of the site and the proximity of infrastructure to the shore, for example Honour Avenue (to the west of the spit) is located adjacent to the foreshore and is undermined during high water level events (see photo above). The Burke Street boat ramp was undermined by storms in 2007 and works were undertaken to address erosion and damage to the ramp.

Renourishment of the shoreline along the reserve has been undertaken on a regular basis to mitigate erosion.

Shore type: Sedimentary (beach) is dominant with some rocky and minor built structures.

Length: Approximately 2 km.

Vested authority (s): City of Melville.

Management strategies: D (renourishment), B (ensure adequate setback), E (appropriate stabilisation works), M (structural monitoring and maintenance plan).

Management recommendations:

Develop whole of foreshore plan to address amenity and environmental values.

Undertake works to address erosion at the Burke Street boat ramp.

Develop a monitoring and maintenance plan to identify when works on structures are required.

Improved mitigation structures are required near Honour Avenue on the western side of Point Walter spit.

Renourishment is required immediately east of the Jetty, which has been previously conducted by the Swan River Trust. Some sediment removal may be required at boat ramps in future.

Future developments should have sufficient foreshore setback to allow for inundation and migration.

Kwinana Freeway, Como / South Perth (Sites S.21–S.22) | **Priority 1**

Description: Extensive reclamation of the Como Foreshore was conducted to construct the Kwinana Freeway (1956-60). A large portion of the original reclamation has subsequently eroded, providing a minimal buffer to wave action. The low elevation freeway is susceptible to inundation during both coastal flooding and severe wave events (red boxes in diagram above). The inundation creates a traffic and pedestrian safety concern, as well as potential damage to infrastructure. The region north of Richardson Street has had a series of groynes and walls constructed that affects longshore sediment transport patterns (yellow box). There is now a net northwards transport with loss of sediment from the beaches to the south.

Shore types: Combination of sedimentary, mixed sedimentary / vegetated and built structure (dominant).

Length: Approximately 4 km.

Vested authority (s): City of South Perth, Main Roads Western Australia, Department for Planning and Infrastructure, Public Transport Authority.

Management strategies: C (address potential for increased flooding and inundation in prone areas), D (renourishment), N (source funds for structural maintenance work) and M (structural monitoring and maintenance plan). In the southern site (S.21), strategy D (renourishment) is a priority with renourishment also beneficial in the northern site.

Management recommendations:

Undertake works to address immediate erosion along this shoreline.

Develop an inundation plan, including investigating a viable management solution to manage the problem of inundation (Appendix 8).

Develop a monitoring plan to identify when works on structures are required with areas of ongoing concern addressed as part of a fast-track application for maintenance funding (e.g. River*bank*).

Undertake foreshore renourishment to provide more sediment to the site and allow for the wider beach to attenuate wave energy before it reaches the structures. Engineering works would be required to ensure any renourishment would retain a degree of stability, due to the influence of historic reclamation on the sediment dynamics.

4.3.3 Swan (Zone 2)

Management priorities are outlined in Table 4.5 and displayed spatially within Figure 4.2 and Figure 4.3. A summary description and management actions for each Priority 1 site is included in the summary tables following Figure 4.3.

Table 4.5 Swan Zone: priority areas for management action aimed at protection and enhancement of the riverbanks and shorelines to mitigate threats to values

Site No.	Location	Value	Condition	Threat	Priority	Strategy No.
S.25	Heirisson Island	Moderate (amenity)	Moderate	Low	3	M, E, B, K
S.26	Causeway to Claisebrook (W)	Moderate (amenity, infrastructure)	Poor	Moderate-High	2	A, D, F, G
S.27	Causeway to Windan Bridge (E)	Moderate (amenity, infrastructure)	Moderate	Low-Moderate	3	C, D, E, F, G
S.28	East Perth Power Station and Banks Reserve	Moderate (amenity, infrastructure)	Poor	Moderate-High	2	F, D, E, B, M
S.29	Bardon Park	Low (amenity)	Moderate	Moderate-High	3	D, F, E
S.30	Balbuk Way Water Ski Area (W bank, formerly Goodwood Parade)	High (infrastructure, amenity)	Poor-Moderate	High	1	D, E, F, G, K, B
S.31	Maylands Peninsula - Golf course to Clarkson Reserve	Low (amenity, environmental)	Poor-Moderate	Moderate-High	3	F, G, K, C
S.32	Cracknell Park to Ascot Water entrance channel	Moderate (infrastructure, amenity)	Moderate	Moderate-High	2	L, F, M, K, B
S.33	Hardey Road Reserve	Low (amenity)	Poor	Moderate-High	2	E, F, K
S.34	Tranby on Swan (including Bath Street Reserve)	High (infrastructure, amenity)	Poor	High	1	E (high priority), F, G, K, B, N with A (in areas)
S.35	Ascot Racecourse	High (infrastructure, amenity)	Poor-Moderate	Moderate-High	1	F, E, K
S.36	Claughton Reserve (Katanning St Boat Ramp)	High (amenity)	Moderate	High	1	F, D, K, G, C, B
S.37	Ashfield Parade / Ron Courtney Island / Garvey Park	High (infrastructure, amenity)	Poor-Moderate	High	1	A (Ashfield Parade), D, E, F, G, K, M, N, C (Garvey Park)
S.38	Sandy Beach Reserve	Moderate (amenity)	Moderate	Low	2	D, F, G

Site No.	Location	Value	Condition	Threat	Priority	Strategy No.
S.39	Sandy Beach Reserve to Helena River confluence (both banks)	Moderate (amenity, infrastructure, environmental)	Moderate	High	2	F, K, B
S.40	Helena / Swan Confluence (including Point Reserve)	Moderate (amenity, environmental)	Moderate	Moderate	3	F, D, E, M, K, C, B
S.41	Lower Helena	Low (environmental, amenity)	Moderate	Low	3	F, A
S.42	Fish Market Reserve	Moderate (infrastructure, amenity)	Poor-Moderate	Moderate	2	E, F, G, C, Boat Ramp
S.43	Success Hill	High (amenity, some infrastructure)	Poor-Moderate	Moderate-High	1	A, B
S.44	St Vincent's Hospital	Moderate (infrastructure)	Moderate	Moderate	3	E, L
S.45	St Vincent's to Woodbridge Riverside Park (including St Charles Seminary)	Moderate (amenity, environmental, infrastructure)	Poor-Moderate	Moderate-High	2	F, K, H
S.46	Lilac Hill (contained within S.45)	High (amenity)	Poor	Moderate-High	1	A, B
S.47	Woodbridge Riverside Park	High (amenity, infrastructure)	Poor-Moderate	Moderate-High	1	E, D, F, M
S.48	John George Walk Trail (Blackadder Creek to Reg Bond Reserve)	Moderate (amenity)	Poor-Moderate	High	2	F
S.49	Midland Brick (private)	Moderate (infrastructure)	Moderate	Low	3	L, K, E
S.50	Middle Swan Bridge Reserve	Low (amenity)	Moderate	High	2	F, G
S.51	Middle Swan Bridge Reserve to Susannah Brook Confluence	Moderate (environmental)	Poor-Moderate	Low-Moderate	3	F, H
S.52	Ellen Brook confluence and All Saints Church	Moderate (amenity, environmental)	Moderate	Low-Moderate	3	J, C
S.53	Upper Swan Bridge and Pullman Park	Low (amenity, infrastructure)	Moderate	Low	3	G
S.54	Bells Rapids Park to Bells Rapids	Moderate (amenity)	Moderate	High	2	A (fencing)

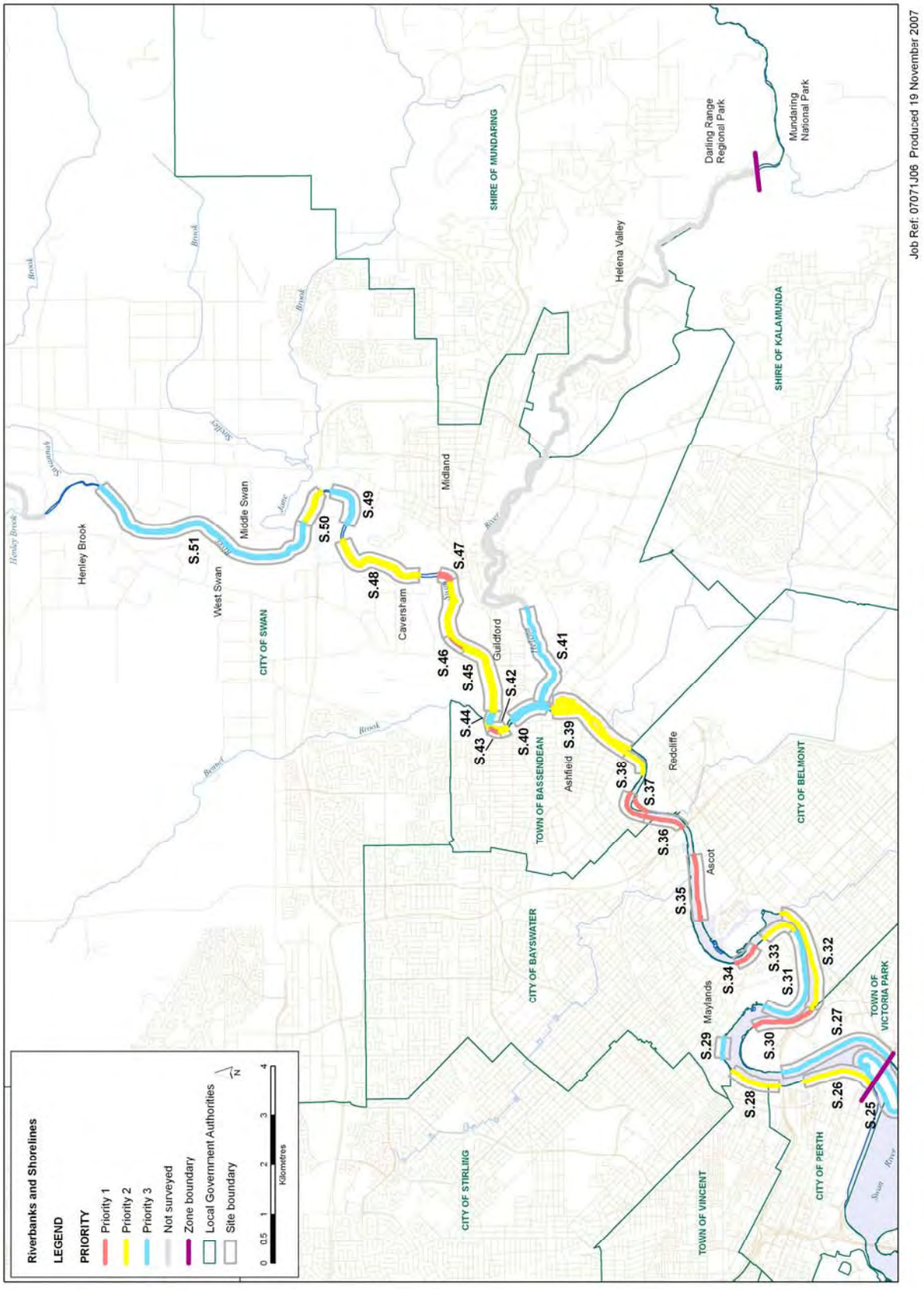


Figure 4.2 **Lower Swan Zone: Priority areas for management action aimed at the protection and enhancement of the riverbanks and shorelines to mitigate threats to values**

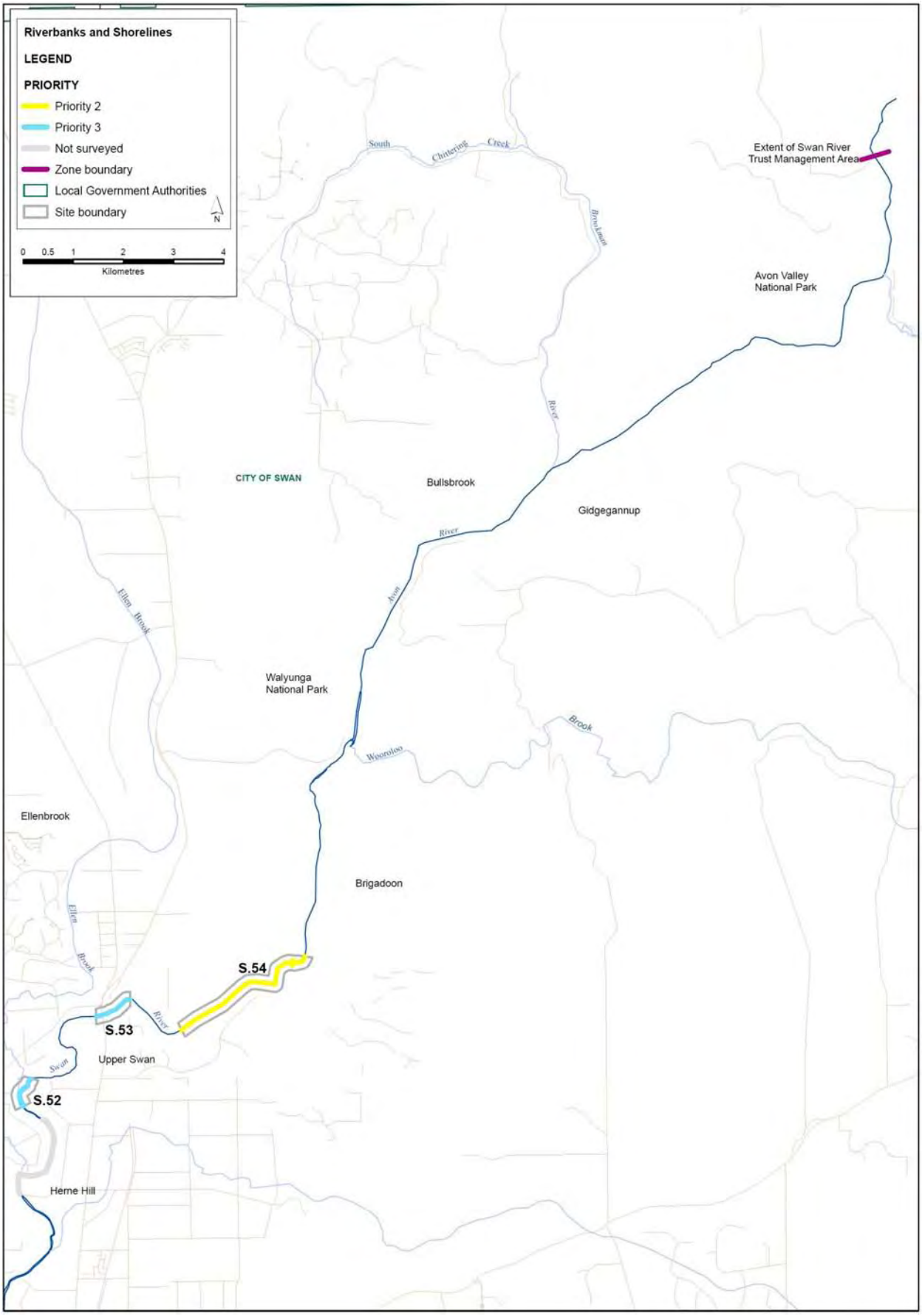
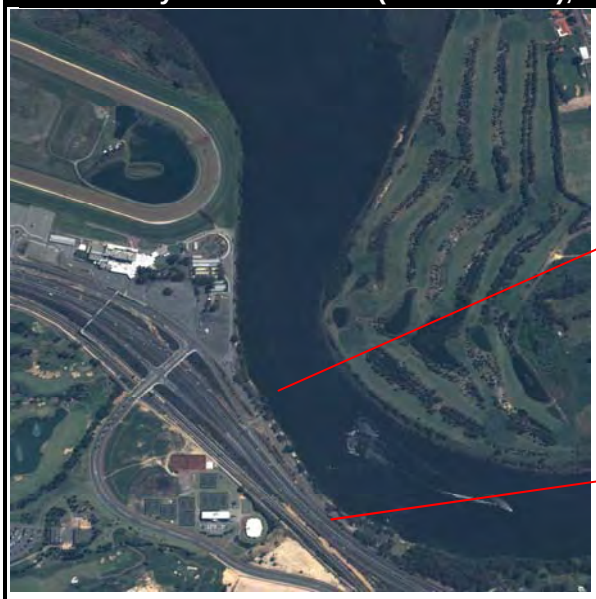
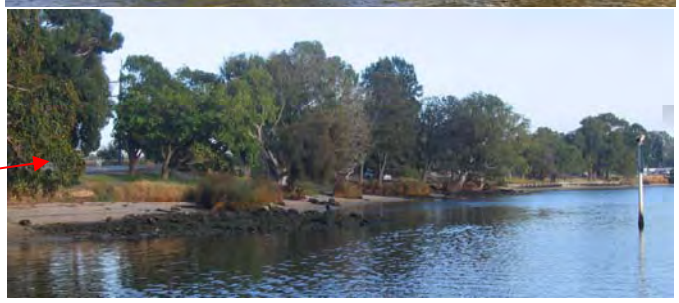


Figure 4.3 **Upper Swan Zone: Priority areas for management action aimed at the protection and enhancement of the riverbanks and shorelines to mitigate threats to values**

Balbuk Way Water Ski Area (western bank), Belmont (Site S.30) **Priority 1**





Description: Balbuk Way left bank is in a water ski area, formerly named Goodwood Parade. The bank sediment is a sandy loam that is generally unconsolidated on the lower bank. The low elevation banks increase in grade and elevation with distance downstream of the boat ramp to Belmont racecourse.

The banks are susceptible to increased wave activity due to turning boats and wave interference. Boat wakes can cause disturbance of the bank sediments which may then be transported by river currents. Further erosive forcing on the banks is due to boats launching / landing, cars parking outside the parking area and general uncontrolled pedestrian access. This destabilises sediments and the narrow coverage of vegetation. At the time of the assessment, gully erosion was occurring as a result of insufficient management of drainage on Balbuk Way and the car park. The banks were exhibiting evidence of undercutting, scarping, vegetation collapse, general and embayed retreat.

A new boat ramp facility was installed in 2002.

Shore type: Mainly sedimentary with some built structures.

Length: Approximately 1.7 km.

Vested authority (s): Town of Victoria Park, City of Belmont.

Management strategies: D (renourishment), E (appropriate stabilisation works), F (revegetation plan), G (manage recreation areas), K (improve boating control and education).

Management recommendations:

Implementation of the City of Belmont's Balbuck Way Management Plan will help reduce the rate of foreshore retreat. It is anticipated that erosion threats will continue to impact on vegetation at the site. This will require continued maintenance to address erosion breaches.

A management strategy for controlling boat launching and landing will assist in reducing bank degradation. The plan could create focal areas for this activity and discourage cars from depositing boats in water, and boats from launching or landing at other locations using bollards and signage.

Renourishment could be an option for key areas of the site downstream of the boat ramp. However, any renourishment should recognise that sediment mobilised by boat wakes is transported rapidly alongshore as the currents are stronger on the outside of a bend.

In areas where retreat is occurring and infrastructure is threatened (near the road or Belmont racecourse), other mitigation measures may be required.

During 2006-07 the City of Belmont partnered with the Swan River Trust and Town of Victoria Park to remove the failing log walling at the ramp and replace it with limestone walling and revetments. Foreshore revegetation works are scheduled for areas adjacent to the hard engineering works.

Tranby on Swan (including Bath Street Reserve), Maylands (Site S.34)	Priority 1

Description: This foreshore is on the Maylands Peninsula and contains the historic Tranby House and Bath Street Reserve. The site is on the outside of a bend with deep water adjacent to the banks. The banks are a sandy loam with areas of brick debris present (dumped material retained as it might increase stability). The bank elevations vary along the site, with significant scarping (3-4 m height) in many areas. The scarping is a public safety concern with general retreat occurring towards the dual use path.

There is a sparse coverage of established trees at the site with many of the trees close to the shore exhibiting exposed roots and undermining.

At Bath Street Reserve, the old concrete sheet piling has damaged units and caused loss of sediment from behind the structure. Downstream of Bath Street Reserve, the banks are characterised by scarping and old log walling at the base that is no longer functional.

Shore type: Degraded built structures.

Length: Approximately 0.7 km.

Vested authority (s): City of Bayswater.

Management strategies: E (appropriate stabilisation works - high priority), F (revegetation plan), G (manage recreation areas), K (improve boating control and education), N (source funds for structural maintenance work) with A (managed migration) in areas not directly adjacent to Tranby House or Bath Street Reserve.

Management recommendations:

Swan River Trust has been working with the City of Bayswater to undertake foreshore restoration works at this site.

Works include path realignment away from the banks, fencing to control public access, opportunistic bank battering to create a more suitable bank slope for revegetation works, rock riprap toe protection and establishment of local native species to enhance bank stabilisation.

The pathway between Tranby House and the river needs to be replaced as does the ‘super 6’ fencing used as a retaining wall at Bath Street Jetty. Associated log walling should also be removed, and if necessary, a suitable alternative constructed. In areas where there are not steeply scarped banks, some minor resloping could also be conducted in conjunction with revegetation and toe stabilisation.

Future developments should have sufficient foreshore setback.

This site will require continued monitoring and maintenance to address breaches in foreshore vegetation in rehabilitation areas.

Ascot Racecourse, Ascot (Site S.35) **Priority 1**

Description: There is a narrow band of riparian vegetation along this straight length of foreshore. A dual use path and Ascot Racecourse are located directly adjacent to the bank. The banks are exhibiting retreat (with undermining and scarping) due to a combination of boat wakes, wind waves, river currents and increased mean water levels. In addition, bank instability has occurred in some locations due to water draining off the path and racecourse onto the bank. The path is being undermined in some locations with tree collapse also evident (see picture). Undermining of the path is a concern for public safety.

Shore type: Mixed vegetated / sedimentary with some minor built structures.

Length: Approximately 1 km.

Vested authority (s): City of Belmont, Perth Racing / WA Turf Club.

Management strategies: F (revegetation plan), E (appropriate stabilisation works), K (improve boating control and education).

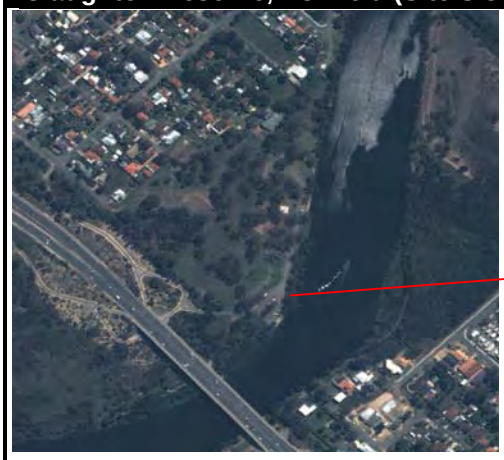
Management recommendations:

Improving the local system of drainage from low points on the path and from the racecourse would reduce the quantity of sediment removed from the banks due to flow over the banks.

A revegetation program should be conducted to widen the vegetation buffer of trees and sedges, improving the bank stability. However, if the bank retreat is resulting in undermining the path, and the path cannot be moved, structural mitigation measures may be required.

This site may benefit from an education program for the public (including signage) about how to minimise boat wake impacts on the bank by modifying boat usage and through the potential modification of speed limits.

Claughton Reserve, Ashfield (Site S.36) **Priority 1**



Description: Claughton Reserve is on the inside of a bend adjacent to the Redcliffe Bridge and containing the Katanning Street boat ramp. This is an area of high recreation usage for boating as well as other land-based recreation. This is a low-lying site that is regularly inundated during surge and high rainfall events. A large car park is located directly adjacent to the foreshore.

The bank sediments are sandy loams often overlying a clay base. There is a narrow band of vegetation present, characterised by a single line of trees that exhibit undercutting of the roots. Tree collapse is evident.

This is a region that is sheltered from significant wind waves and is vulnerable to boat wakes.

Shore type: Mixed vegetated / sedimentary with a thin band of vegetation.

Length: Approximately 0.5 km.

Vested authority (s): City of Bayswater.

Management strategies: F (revegetation plan), D (renourishment), K (improve boating control and education), G (manage recreation areas), C (address potential for increased flooding and inundation in prone areas).

Management recommendations:

A revegetation plan is required for both banks along this section of river to slow the rate of foreshore retreat. It is anticipated that the vegetation will continue to be undermined and damaged due to the forcing at the site, and at Claughton Reserve, a wide buffer of trees should be planted.

A management strategy for controlling boat landing will assist in reducing bank degradation. Bollards have been placed along the car park to discourage cars from launching or landing boats other than at the boat ramp. The plan could discourage boats from landing on the banks after being launched, through the use of signage, revegetation and the potential addition of a jetty.

This site may benefit from an education program for the public (including signage) about how to minimise boat wake impacts on the bank by modifying boat usage, and through the potential modification of speed limits.

Renourishment could be an option for some embayed sections of the foreshore upstream of the boat ramp, in conjunction with revegetation. The sediment used for the nourishment / resloping should be similar to the sediment naturally occurring at the site.

Develop an inundation plan including accounting for periods of loss of function of the boat ramp and methods for draining the excess water from the car park following inundation events. No mitigation techniques should be required to reduce inundation as there is no significant infrastructure directly threatened by inundation, other than the car park and boat ramp.

Ashfield Parade / Ron Courtney Island / Garvey Park, Ashfield (Site S.37)	Priority 1

Description: The section of shoreline on the outside of the bend adjacent to Ashfield Parade has been a site of ongoing erosion. There are houses, Ashfield Parade and a dual use path in proximity to the scarping bank. The outer bank has a high clay content in its lower section. The high erosion scarps have been a concern for public safety for decades. The channel which separates Ron Courtney Island (RCI) from Garvey Park was excavated in 1969 in an effort to alleviate the erosive forces due to the river flow. The artificial channel was originally sustained by log walling that has experienced a significant loss of function or condition in many areas.

One of the processes that causes these erosion scarps is the undercutting and subsequent collapse of the bank. The bank is relatively stable until the river currents remove the collapsed sediment from the base of the bank.

The majority of the upstream, downstream and the southern sides of RCI were characterised by built structures, with most of the log walling no longer functional. The upstream end of the island is protected by a limestone revetment that needs maintenance. The island may only be accessed by kayakers or boats and has no infrastructure on it.

Garvey Park is located on the left bank and is characterised by a mixture of log walling, walling and a kayak launching area combined with sedges. Embayed retreat, loss of sedges and erosion through gaps in the log walling are occurring. The walling adjacent to the kayak club is being undermined. Scarping is exhibited downstream and upstream of this location with a dual use path located near to the shore.

Shore type: Mainly degraded built structures with some sedimentary (scarp) and vegetated.

Length: Approximately 2.2 km.

Vested authority (s): Town of Bassendean, City of Belmont, Swan River Trust (RCI).

Management strategies: A (managed migration at Ashfield Parade), D (renourishment), E (appropriate stabilisation works), F (revegetation plan), G (manage recreation areas), K (improve boating control and education), M (structural monitoring and maintenance plan), C (address inundation: Garvey Park).

Management recommendations:

The Town of Bassendean has been working with the Swan River Trust in the development of a foreshore rehabilitation plan for Ashfield Parade. This will be implemented over a number of years from 2008.

Shore migration at Ashfield Parade will be managed by restricting public access, undertaking opportunistic revegetation across the scarp face, and dense revegetation at the top of the embankments. Variable toe protection techniques will be used to trap slumped banks and increase the structural integrity. Management of stormwater and sub-surface water flows by modifying surface drainage and dense revegetation will also help reduce erosion from surface and sub-surface flows.

The revetment at the upstream end of Ron Courtney Island should be maintained with additional units placed at the crest of the structure.

Many of the log walls at Garvey Park are missing units or have lost function. It may be possible to remove some of the structures and investigate resloping the banks and revegetating, allowing for retreat rather than maintaining a fixed location with walling. If structures are maintained or rebuilt, regular monitoring and maintenance work is required for public safety. Consideration should be given to the location of the dual use path along this area.

A revegetation plan is required across Garvey Park to address foreshore retreat.

Success Hill, Bassendean (Site S.43) **Priority 1**

Description: The section of shoreline on the outside of the bend adjacent to Success Hill Reserve has been a site of ongoing erosion. There are private houses and a recreation reserve near the scarping bank. The bank sediments are sandy clays with high erosion scarps along its length. Following undercutting and subsequent collapse, the bank is relatively stable until the river currents remove the collapsed sediment from the base of the bank.

A jetty is located within this reach.

Shore type: Mixed vegetated / sedimentary and sedimentary (scarp).

Length: Approximately 0.6 km.

Vested authority (s): Town of Bassendean.

Management strategy: A (managed migration).

Management recommendations:

Managed migration is recommended for the steep scarped banks of Success Hill, with fencing placed for public safety. Minor nourishment, combined with revegetation and flow mitigation structures at the base, may act to slow the rate of material removed at the base of the scarp, reducing undercutting and the potential rate of scarp erosion. However, this would need to be repeated and could not be sustained through flood conditions.

Lilac Hill, Caversham (Site S.46) **Priority 1**

Description: The section of shoreline on the outside of the bend adjacent to Lilac Hill Reserve has been a site of ongoing erosion. There is limited recreation use in the vicinity of the scarp. The bank sediments are sandy loams overlying clay with high erosion scarps along its length. Following undercutting and subsequent collapse, the bank is relatively stable until the river currents remove the collapsed sediment from the base of the bank.

Shore type: Mixed vegetated / sedimentary and sedimentary (scarp).

Length: Approximately 0.4 km.

Vested authority (s): City of Swan.

Management strategy: A (managed retreat).

Management recommendations:

Managed retreat is recommended for the steep scarped banks of Lilac Hill, with fencing placed for public safety. Pedestrian access along the right bank should be directed to avoid the scarped and undermined section of bank.

Woodbridge Riverside Park, Woodbridge (Site S.47) **Priority 1**

Description: Woodbridge Riverside Park contains West Midland Pools, a kayak club, car park and a walking trail upstream from the site. The site is a significant recreation area for the public and students of Governor Stirling High School. West Midland Pool was a location of historic aquatic recreation. The site contains walling of concrete sheet piling, and until 2004, it also contained two jetties for recreation. The walling is in disrepair and public safety would be improved if some maintenance or rebuilding work was conducted on the walling.

The kayak club is located on the bank with an adjacent eroding (embayed retreat) bank used to launch and land the kayaks.

Historic log walling exists between West Midland Pool and the kayak club, with only the vertical stumps remaining for most of the structure length.

Significant scarping, undercutting and embayed retreat occurs across the site, with the bank elevation increasing with distance upstream.

Shore type: Built structure and mixed vegetated / sedimentary, including an eroded beach.

Length: Approximately 0.5 km.

Vested authority (s): City of Swan.

Management strategies: F (revegetation plan), E (appropriate stabilisation works), D (renourishment), M (structural monitoring and maintenance plan).

Management recommendations:

Implementation of the Swan Riverside Regional Park Revegetation and Management Plan developed by the City of Swan with support from the Swan River Trust. Planned foreshore rehabilitation works include formalising pathways setback from the river's edge, erosion control works, including woody debris placement, erosion control matting and planting of local native vegetation.

Remove the old log walling downstream of the kayak club, and if necessary, replace with another protection measure. Minor renourishment of the kayak launching beach may be required.

Monitor and maintain the West Midland Pool structure with potential to rebuild with a structure that has recreational function and improved public safety.

A revegetation plan is required upstream of the West Midland Pools to slow the rate of foreshore retreat. In many areas, the foreshore is sustained by a single line of trees with no vegetation behind. This plan would involve planting trees and sedges to create an adequate buffer of vegetation to allow for periodic loss. All revegetation works should also be monitored and maintained where breaches occur.

4.3.4 Canning (Zone 3)

Management priorities are outlined in Table 4.6 and displayed spatially within Figure 4.4. A summary description and management actions for each of the Priority 1 sites is included in the summary tables below Figure 4.4.

Table 4.6 Canning Zone: Priority areas for management action aimed at the protection and enhancement of the riverbanks and shorelines to mitigate threats to values

Site No.	Location	Value	Condition	Threat	Priority	Strategy No.
S.55	Mount Henry and Aquinas Bay	High (amenity, environmental)	Moderate	Moderate	2	D, F, M
S.56	Salter Point	Moderate (amenity, infrastructure)	Moderate	High	2	D, F, G
S.57	Salter Point West (Salter Point to Curtin University Boat Club)	Moderate (amenity, environmental)	Moderate	Low	3	F, B, C
S.58	Clontarf to Shelley Bridge	Moderate (infrastructure, amenity, environmental)	Poor	Low-Moderate	3	F, B, C
S.59	Leach Highway offramp (Centenary Avenue)	High (infrastructure)	Moderate	High	1	E
S.60	Bull Creek (W)	Moderate (infrastructure)	Moderate	Moderate-High	2	F, D, G
S.61	Shelley-Rossmoyne Foreshore (Bull Creek to Shelley Bridge)	High (amenity, infrastructure)	Moderate	Moderate	2 (localised areas of 1)	F, G, D, L, E, A
S.62	Shelley Bridge to Riverton Bridge (both banks)	Moderate (amenity)	Poor	High	2	F, G, D
S.63	Kent Street Weir	High (infrastructure)	Poor	High	1	M, E, N
S.64	Masons Landing Park	Moderate (amenity)	Poor	Low	3	F, G
S.65	Hester Park	Moderate (amenity)	Poor	Low-Moderate	3	F, G
S.66	Djarlgarra Bridge (Roe Hwy) to O'Dell Street	High (infrastructure)	Moderate	Low	2	M, D, E
S.67	Bickley Brook to scarp on Southern and Canning Rivers	High (infrastructure, amenity, environmental)	Poor	High	1	I, J, L, A, B (All high priority), G, H
S.68	Ferres Drive Bridge	Moderate (infrastructure)	Moderate	Moderate	3	M

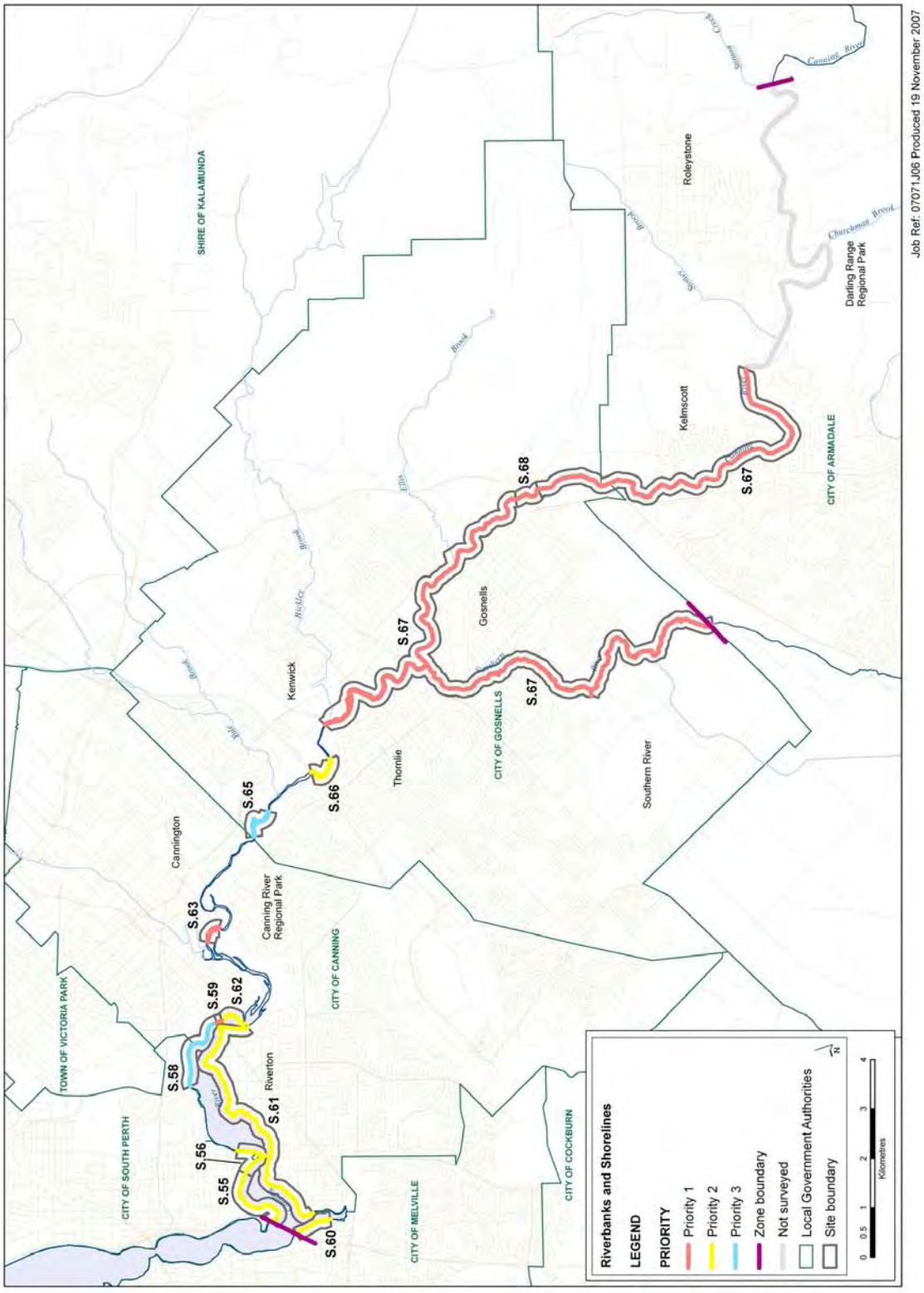


Figure 4.4 **Canning Zone: priority areas management action aimed at the protection and enhancement of the riverbanks and shorelines to mitigate threats to values**

Leach Highway Offramp (Centenary Avenue), Wilson (Site S.59) — Priority 1

Description: The Leach Highway Offramp onto Centenary Avenue in Wilson is located close to the Canning River Foreshore. In this location, the road and dual use path are located less than 10 m from the shoreline. The dual use path is separated from the shoreline by a grassed section of foreshore with wave baffles placed at the toe. This site is susceptible to wind waves and surge.

Shore type: Vegetated.

Length: Approximately 0.1 km.

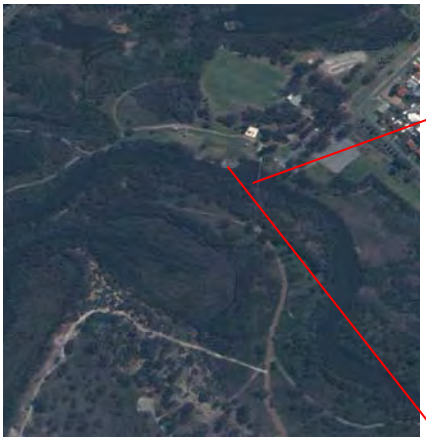
Vested authority (s): City of Canning.

Management strategy: E (appropriate stabilisation works).

Management recommendations:

Install a new structure that provides appropriate protection for the dual use path and roads in conjunction with removing the baffle boards. One option could be a revetment with sedge planted in front of the structure. The structure would need to be deeply embedded as this site is likely to be a separation point in wave-induced sediment transport.

Kent Street Weir, Wilson (Site S.63) **Priority 1**



Description:

Kent Street Weir was installed to sustain both a freshwater environment upstream of the weir, and the water levels in the Canning for abstraction purposes. The weir can result in an elevation step up of 0.5 m in summer upstream of the structure. Maintenance of the structure is required for the ecosystem balance upstream. As at January 2007, the weir was in general disrepair with bowed weir boards (leaking water) and structural strain on the wooden path above the weir.

The gabions, walling and steps downstream of the weir had missing units and were exhibiting rotation and slumping at the time of assessment.

Shore type: Built structure and mixed vegetated / sedimentary.

Length: Shore normal weir, with surrounding structures covering approximately 0.1 km.

Vested authority (s): City of Canning, Swan River Trust, Department of Water.

Management strategies: E (appropriate stabilisation works), M (structural monitoring and maintenance plan), N (source funds for structural maintenance work).

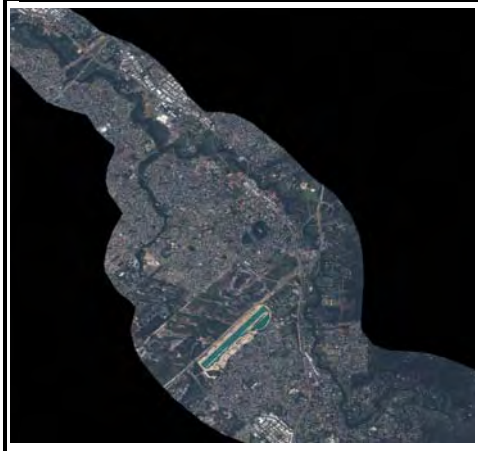
Management recommendations:

The City of Canning, with support from the Swan River Trust, replaced the failing gabions in 2007 with a limestone retaining wall with increased embedment and elevation. Bank battering and revegetation with local native species is scheduled for the section of foreshore downstream of the gabions. Ongoing monitoring and maintenance of revegetation works will be necessary.

Immediate maintenance / repair works are required on the weir. This is the responsibility of the Department of Water, which is preparing to undertake a detailed study on the feasibility of long term options.

Develop a monitoring plan to identify when maintenance works on the weir are required as part of a fast-track application for maintenance funding.

Bickley Brook to scarp on Southern and Canning Rivers (Site S.67) **Priority 1**



Description: The Canning and Southern Rivers between the scarp and Bickley Brook are located within agricultural zones and conservation areas. There is a mix of infrastructure, significant environmental sites and areas of recreational amenity.

Widespread sedimentation is occurring across this section of river, mainly due to flow regulation as a result of dam creation for metropolitan water supply. There is insufficient flow to scour the river of sediment, with enhanced sediment inputs from tributary modification and entering from drains. If the ambient river flow is not increased, sedimentation will continue to decrease the channel cross-section. This will modify flow patterns and is likely to increase bank migration and cause the channel location to fluctuate.

Shore type: varied mainly between vegetated and mixed vegetated / sedimentary. Some built structures (bridge abutments) present.

Length: Approximately 19 km.

Vested authority (s): City of Gosnells, City of Armadale.

Management strategies: I (reduce sedimentation), J (sediment management plan), L (drainage retrofit and stormwater management plan), A, (managed migration), G (manage recreation areas), H (animal trampling fencing). Note: I, J, L and A – All high priority.

Management recommendations:

The four priority works required for this area are:

- Investigate measures to reduce sedimentation, including: increased river flow through dam release of the Canning and Victoria Dams; review of private abstraction licences along the Canning and Southern Rivers to ensure sufficient environmental flows; and sediment extraction or removal of artificial barriers to flow (including *ad hoc* dams for private abstraction). Sediment extraction would not generally be encouraged as a management solution on a river with the capacity to flow, as the sediment would naturally scour under an extreme event. However, as the Canning is a regulated system, only experiencing 2 per cent of the pre-dam flows, it is unlikely that the sediment will scour naturally.
- Develop a plan to reduce the quantity of sediment entering the river from the catchments, tributaries, construction sites and other sources (such as at the recently constructed Tonkin Highway Bridge).
- Encourage retrofitting of existing drainage structures to incorporate sediment traps and design features to minimise scour. The drains in this area were supplying significant quantities of construction sand to the river, in addition to removing sediment from the banks due to scour. Inadequate stormwater capacity results in water flowing over the banks, destabilising the banks and resulting in increased sedimentation.
- Managed migration is recommended in all areas of this section of the river that are not adjacent to bridge abutments.

Lower priority works for this site include a recreation management plan to discourage construction of bicycle paths and BMX jumps, along with uncontrolled pedestrian access. Animal trampling was also observed along the banks in some areas and fencing should be encouraged.

4.4 Vegetation Issues and Management

4.4.1 Issues

There were five main issues for vegetation observed across the Swan Canning system. These include:

1. Loss of vegetation connectivity.
2. Loss of structural complexity.
3. Threat of invasive species.
4. Degradation of regionally significant vegetation.
5. Limited effectiveness of effort and / or coordination.

The issues facing each zone are discussed in more detail in the following sections.

4.4.1.1 Estuary (Zone 1)

The Estuary foreshore is characterised by its loss of riparian vegetation through infilling and dredging, shore levelling and clearing. Along the Estuary, modifications to the shore have been significant, with approximately 21.7 km featuring built retaining structures, which have been used to construct an artificial shore. Generally, these areas were once the lower lying saltmarsh, mudflat or swamp environments. Where native vegetation remains fringing the river, it is often in narrow bands, discontinuous or isolated and is therefore vulnerable to further degradation.

Areas of regionally significant saltmarsh and sedgeland are protected within the Swan Estuary Marine Reserve while a number of Bush Forever sites contain remnants of native vegetation along the variable shoreline and above the steep escarpments. Good condition remnant vegetation is now very poorly represented across the Zone, and remaining vegetation is threatened by a range of degrading impacts, which are diminishing conservation and biodiversity value.

Remnant vegetation in natural areas is most significantly impacted on by invasive weed species, which have the potential to out-compete, smother and displace native species. Where a remnant overstorey persists within a parkland environment, the intensive management of lawn below established trees is most common and limits the regenerative potential, representing a future deficit once these trees die due to natural attrition.

Inadequate containment of lawn is also impacting on remnant areas and rehabilitation sites, and in many instances, could be easily addressed by the utilisation of existing pathways as barriers between revegetation and lawn.

A significant constraint to the incorporation of tree species within revegetation programs has been the fierce opposition from landowners who are often solely concerned about disruption to river views. This general resistance is also reflected by the incidences of tree vandalism, which has resulted in the death of isolated remaining overstorey at times. Tackling these issues is necessary for the long term protection and reinstatement of environmental values within the Estuary.

4.4.1.2 Swan (Zone 2)

Unlike the Estuary foreshore, there is much better representation of saltmarsh and sedgeland environments along the Swan. However, these areas are being impacted upon by a range of invasive species. Mitigating further degradation is important for vegetation protection and will be vital to any rehabilitation effort.

Unfortunately, on higher ground more suitable for development and agricultural practice, vegetation has been extensively degraded. Remaining vegetation often persists in narrow bands, providing inadequate buffering of the shore and an inadequate habitat corridor. Good

condition vegetation is often isolated within a mosaic of more degraded and highly modified vegetation.

Within the narrow bands of fringing vegetation that remains, the understorey is often dominated or encroached upon by exotic sedges and native overstorey regeneration is often restricted, especially along the mid and lower Swan River. Without new recruits to replace trees or shrubs that will eventually die of natural attrition, or as a result of erosion of exposed shorelines, a potential net deficit in native overstorey species can be expected. Further thinning of an already open overstorey is likely to lead to marked structural changes resulting in greater exposure and erosion of sedimentary shores and banks.

Another important issue is the absence of native species regeneration within a large proportion of sites shown to be experiencing crown death. Unless this issue is addressed, the loss of vegetation without replacement via natural regeneration or revegetation will lead to an overall loss in vegetation structure and function.

4.4.1.3 Canning (Zone 3)

The most significant issue impacting upon native vegetation structure and function along the Canning is the degradation and loss of understorey species. This is particularly important along the mid and upper Canning and Southern rivers.

The dominance of invasive weed species is most prolific along the Canning and is resulting in widespread degradation. Invasive species pose a constant threat to areas of regional significance and sites of rehabilitation effort. Their management will rely on the engagement and commitment of private landholders contributing to invasive species control activities.

A large area of regionally significant vegetation along the mid to upper Canning is degraded. Further degradation could result in significantly diminished conservation and biodiversity values.

Some of the best condition vegetation along the whole of the Swan Canning system remains along the Canning foreshore. However, this is severely threatened by the invasion of a range of exotic species.

4.4.2 Management strategies

Strategies for management of the five main issues facing foreshore vegetation include:

- Improving connectivity by expanding good condition vegetation.
- Improving the structural complexity of vegetation in regionally significant areas.
- Containing invasive weeds in poor condition areas; effectively managing invasive weeds in moderate condition areas; and eradicating from good condition areas.
- Maintaining rehabilitation areas.
- Encouraging the development of foreshore management plans for all regionally significant areas.
- Promoting development of best management practice in foreshore vegetation management.
- Supporting community awareness and engagement initiatives in foreshore management.

Management strategies have been developed for each issue to protect, enhance and manage fringing indigenous vegetation and habitat (Table 4.7). The specific area that the strategies relate to is shown in that table.

Table 4.7 Management strategies to protect, enhance and manage fringing indigenous vegetation and habitat

Issue	Management strategy	Estuary locations	Swan locations	Canning locations
Loss of connectivity	**O:** Improve linkage between regionally significant and good quality vegetation areas (including lateral connectivity to floodplain and wetlands) through planning and action.	Peppermint Grove foreshore (V.9) to Point Resolution Reserve (V.5); Alfred Cove (V.1) to Point Heathcote (V.8); Milyu Nature Reserve (V.3) to Mount Henry Bushland (V2).	All sites within the lower to mid Swan River i.e. both sides of the riverbank from Burswood Park (V.26) to the Reg Bond Reserve within V.14).	Good condition sites within the Canning River Regional Park (V.31); along the Canning and Southern rivers (within V.33); between Collins Road (V. 35) and Croyden Road Roleystone (V.38).
	P*:* Address localised breaches in fringing sedge vegetation.	Blackwall Reach and Alfred Cove (V.1); Melville Beach Road, Applecross; Waylen Bay foreshore, Applecross; the Esplanade, Mount Pleasant; and from Milyu Nature Reserve (V.3) to Mount Henry Bushland (V2).	From south Garvey Park (V.18) to upper Swan River.	Mount Henry (V.2) to the Nicholson Road bridge, Langford (including Salter Point to Wilson V.30 and Canning River Regional Park V.31); and the Shelley-Rossmoyne foreshore from Yagan wetland to the Canning River Regional Park.
Loss of complexity	**Q***:* Establish structural integrity of vegetation in regionally significant areas.	Narrow section of Alfred Cove Nature Reserve (V.1).	Swan River to Jane Brook, Ashfield to upper Swan Bush Forever site (302) (V.14).	Canning and Southern rivers, Beckenham to Kelmscott Bush Forever Site (246) (V.33).
	R*:* Increase the vegetative buffer width and structural complexity of foreshores where susceptible to erosion.	Melville Beach Road, Applecross; Jeff Joseph Reserve to Point Heathcote (V.8); the Esplanade, Mount Pleasant; and Milyu Nature Reserve (V.3) to Mount Henry Bushland (V2).	Both sides of the river from Burswood Park 9V.26) to end of Swan River to Jane Brook, Ashfield to Upper Swan Bush Forever site (302) (V.14).	Salter Point; Shelley-Rossmoyne foreshore and Nicholson Road to Bickley Brook.
	S*:* Where appropriate, establish no mow zones under remnant overstorey to allow for regeneration.	As appropriate across Zone.	As appropriate across Zone.	As appropriate across Zone.
	T*:* Support tree replacement programs, awareness raising and actively discourage tree vandalism.	Across Zone.	Across Zone.	Across Zone.
Invasive species	**U***:* Target highly invasive weeds species through coordinated / cross boundary effort.	Across Zone.	Across Zone.	Across Zone.
	V*:* Ensure Best Management Practice in weed control and rehabilitation work.	Across Zone.	Across Zone.	Across Zone.
	W: Support removal of exotic grasses and replacement with local native species between the river and riverside pathways, allowing for designated grassed recreation areas in the vicinity of recreational infrastructure.	Across Zone, especially along Blackwall Beach Parade, Bicton; Melville Beach Road and Jeff Joseph Reserve, Applecross; and the Esplanade, Mount Pleasant.	Across Zone where applicable.	Across Zone where applicable.

Issue	Management strategy	Estuary locations	Swan locations	Canning locations
Degradation of regionally significant vegetation	**X:** Encourage development of foreshore management plans for all significant areas. To include controlled foreshore access, management of degrading influences, integrated weed management and management of recreation nodes.	Across Zone.	Across Zone.	Across Zone.
	Y: Increase profile of regionally significant sites and raise foreshore user awareness of values and degrading behaviours through development of interpretive trails / signage and information resources etc.	Across Zone.	Across Zone.	Across Zone.
	Z: Promote the establishment of low or no wash zones around ecologically sensitive areas.			Canning River Regional Park (V.33).
Effectiveness of effort / coordination	**AA:** Monitor condition and effectiveness of rehabilitation activity, trial innovative techniques for addressing degradation and provide extension role to land managers.	Across Zone.	Across Zone.	Across Zone.
	AB: Trial approaches to improve revegetation success and weed control.	Across Zone.	Across Zone.	Across Zone.
	AC: Support community and private effort in rehabilitation and awareness raising activities.	Across Zone.	Across Zone.	Across Zone.

4.5 Priorities for Action–Vegetation

4.5.1 Method of prioritisation

All sites of conservation value and / or areas of best condition vegetation were considered to be an important priority for management, and were further assessed to establish their relative importance. This was achieved by considering the degree of conservation value of sites, the overall vegetation condition and the threat of potential deterioration. A simplified system was used to assess the priority of sites based on assigning a score of high, medium or low against these three factors (Table 4.8).

To ensure management priorities were defined at an operationally meaningful scale, sites were considered at the management boundary scale where appropriate. For example, all conservation value sites were assessed based on their reserve boundary, and not at the individual vegetation unit scale. The exception to this is where highest condition vegetation has been included and it does not correspond to a regionally significant site. In this case, the boundary of the vegetation unit was used.

Sites were then grouped according to similarity of management response, relation to land management boundaries and proximity to each other. This enabled opportunities for linkage of management to be identified. Groupings were used to define broad management areas. Specific recommendations for management within these broad areas are provided.

Table 4.8 Process for scoring sites for prioritisation related to vegetation

Themes		Conservation or biodiversity value	Vegetation condition	Potential for deterioration				Overall ranking
Assessment criteria		*Conservation* site overlaps with: • A Class Nature Reserve; • Marine Park; • Bush Forever; • EPP Wetland. *Condition* site contains: • best condition vegetation.	Proportion of total vegetation in each condition category of: • Good; • Moderate; • Poor.	• Total management priority scores for invasive species*. • Range of degrading influences. • Erosion evidence at site.				Each location is to be considered against each criteria for the three factors or themes considered.
				Invasive species mgt score	**Number of degrading influences**	**Degree of erosion**		
Score	High	Meets two or more conservation criteria.	Good - majority of area is in good condition.	High = >30	High = 7 to 18	High = prominent across site.	A single score is given based on the 'median' of the three scores for potential deteriorate-ion.	Overall Priority Ranking is assigned as Priority 1, Priority 2 or Priority 3 based on the 'median' score across the three themes.
	Medium	Meets any one conservation criterion.	Moderate - majority of area is in good to moderate condition.	Moderate = 16 to 30	Moderate = 4 to 6	Moderate = scattered throughout site.		
	Low	Meets condition criterion only.	Poor - majority of area is in moderate to poor condition.	Low = 0 to 15	Low = 0 to 3	Low = limited.		

*Note: see Appendix 2 for an explanation of management priority scores assigned for invasive species.

Priority sites are grouped under three broad categories, with the highest priority site being Priority 1. To ensure management priorities and recommendations are made at an operationally meaningful scale, sites are considered at the management boundary scale where appropriate.

4.5.2 Estuary (Zone 1)

Management priorities are outlined in Table 4.9 and displayed spatially within Figure 4.5. Management areas are defined to provide a context for management and to facilitate application of management recommendations across a broader area to facilitate action for site linkage and promote action across management boundaries.

Table 4.9 Estuary Zone: Priority sites for management action aimed at the protection, enhancement and management of the fringing indigenous vegetation and habitat

Site	Location	Conservation or Biodiversity Value	Vegetation Condition	Potential for deterioration: Invasive species	Potential for deterioration: Degrading influences	Potential for deterioration: Evidence of Erosion	Potential for deterioration: Overall Score	Priority ranking	Mgt Area
V.1	Blackwall Reach, Point Walter, Alfred Cove and adjacent bushland, Bicton to Applecross.	High A Class Nature Reserve 35066 Marine Park (M4) Bush Forever 331 Condition 1 veg = 1 ha (Alfred Cove)*.	Poor	High (56) (48)	High (9) *(3)	Moderate	High	1	
V.2	Mount Henry Bushland, Salter Point.	High Bush Forever 227 EPP Wetland UFI 798 Condition 1 veg = 2.2 ha.	Good	Moderate (16)	Moderate (5)	Moderate	Moderate	1	
V.3	Milyu Nature Reserve, South Perth.	High A Class Nature Reserve 33803 Marine Park (M4) Condition 1 veg = 0.9 ha.	Good	Low (15)	Low (3)	Moderate	Low	1	
V.4	Pelican Point, Crawley.	High A Class Nature Reserve 40891? Marine Park (M4) Bush Forever 402.	Moderate	High (35)	Moderate (4)	Low	Moderate	2	
V.5	Point Resolution Reserve, Dalkeith.	Moderate Bush Forever 221.	Moderate	Moderate (24)	Moderate (4)	Low	Moderate	2	
V.6	Chidley Point and adjacent bushland, Mosman Park.	Moderate Bush Forever 334.	Poor	High (32)	Moderate (6)	Low	Moderate	2	
V.7	Minim Cove, Mosman Park.	Moderate Bush Forever 335.	Poor	Moderate (25)	Moderate (6)	Moderate	Moderate	2	
V.8	Point Heathcote, Applecross.	Moderate Bush Forever 329.	Moderate	Moderate (18)	Low (3)	Low	Low	2	
V.9	Peppermint Grove Foreshore.	Moderate Bush Forever 403.	Moderate	Low (12)	Low (1)	Low	Low	2	
V.10	Gilbert Fraser Reserve, North Fremantle.	Low Condition 1 veg = 2.0 ha.	Good	Low (3)	Low (0)	Low	Low	3	
V.11	Rocky Bay, Mosman Park, North Fremantle.	Low Condition 1 veg = 0.5 ha.	Good	Low (3)	Low (0)	Low	Low	3	
V.12	Canning Beach Road, Coffee Point, Applecross.	Low Condition 1 veg = 0.2 ha.	Good	Low (0)	Low (1)	Moderate	Low	3	

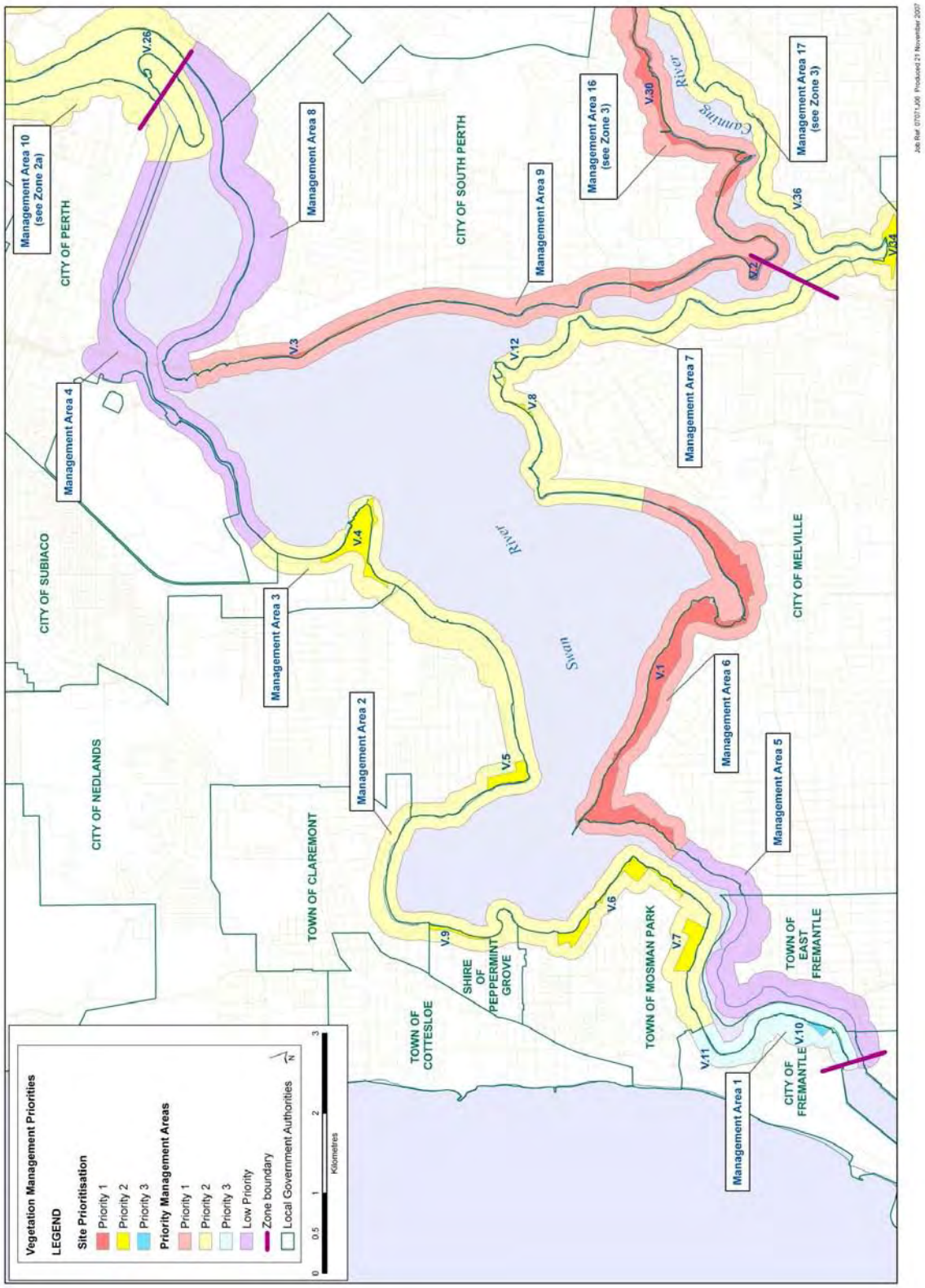


Figure 4.5 Estuary Zone: Priority areas for management action aimed at the protection, enhancement and management of fringing indigenous vegetation and habitat

Management Area 1 - Fremantle traffic bridge to Rocky Bay, North Fremantle (western foreshore) | **Priority 3**

Description:

Northern bank from the Fremantle traffic bridge to the boundary of City of Fremantle and Town of Mosman Park. The area has undergone dramatic modification. Exposed cliff faces are a result of extensive quarrying. Intensive land use and residential encroachment have impacted on vegetation across this area (Swan River Trust 1997).


Gilbert Fraser Reserve


Rocky Bay (south)


Rocky Bay (north)

Priority sites:

Site V.10: Gilbert Fraser Reserve, North Fremantle (Priority 3 Site)

A reconstructed tidal wetland in the vicinity of former Prawn Bay, in-filled during the 1960s. The area was rehabilitated by the City of Fremantle in 2003, with support from various partners, including the Swan River Trust. Major works included inlet construction, revegetation and installation of public amenity infrastructure.

Site V.11: Rocky Bay, North Fremantle (Priority 3 Site)

This site is within a series of steep limestone cliffs. The cliffs were quarried from 1890, substantially changing the elevation of the landscape and natural vegetation. A small section of the cliffs contains high quality native vegetation.

Vested authority (s): City of Fremantle.

Management strategies (refer to Table 4.7):

T, U, V, X, Y, AA, AB, AC.

Management recommendations:

- Eradicate invasive species at Gilbert Fraser Reserve and Rocky Bay as a first priority, including *Brassica tournefortii, Arundo donax and Leptospermum laevigatum*. Extend weed treatment to good and moderate condition vegetation across management area.
- In the short term, contain invasive species in poor condition areas across the management area. Prioritise species for effective management based on a) risk of invasiveness and b) ease of eradication.
- Control grasses associated with recreational nodes across the management area to avoid encroachment into natural vegetation.
- Expand best condition vegetation at Gilbert Fraser Reserve and Rocky Bay and link sites of good condition vegetation.
- Encourage natural regeneration of shrub and tree species.
- Investigate causes of shrub death at Gilbert Fraser Reserve.
- Manage foreshore access to avoid trampling of vegetation and remove dinghies from foreshore.

Management Area 2 - Rocky Bay to JH Abrahams Reserve, Subiaco | **Priority 2**

Description:

Includes the steep outcrops of coastal limestone from the north eastern end of Rocky Bay to the modified foreshores dominating the most eastern boundary of the City of Nedlands. The management area includes the relatively sheltered foreshore reserves of Mosman and Freshwater Bays.

Sections of foreshore have been extensively modified by limestone quarrying between the 1850s and 1900s. Intensive land use and residential encroachment have impacted on vegetation across this area. It has a long history of clearing and development and contains Perth's earliest estate suburb, Claremont. The Nedlands foreshore has also been extensively reclaimed using dredge spoil to establish the flat reserves, which are protected from erosion by retaining walls (Swan River Trust 1997).


Point Resolution


Point Resolution


Chidley Point


Mosman Bay


Minim Cove


Peppermint Grove

Priority sites:

Extensive quarrying was carried out in the mid 1800s through a convict work program to provide material for road construction. The area has considerable indigenous cultural value, along with Point Walter on the opposite bank.

Site V.5: Point Resolution Reserve, Dalkeith (Priority 2 Site)

The reserve is a mix of open parkland with an overstorey of remnant local species and exotic tree species. A short steep slope leads to coastal limestone pinnacles and emergent rocks within a beach area. This section of the reserve supports local indigenous vegetation. The reserve is a recognised Bush Forever site (221).

Site V.6: Chidley Point and adjacent bushland, Mosman Park (Priority 2 Site) and

Site V.7: Minim Cove, Mosman Park (Priority 2 Site)

Extensive modification from limestone quarrying and intensive land use has resulted in substantial modification to the natural vegetation. However, large remnant vegetation communities remain between Minim Cove and Chidley Point. Both areas are recognised bush forever sites (335 and 334).

Site V.9: Peppermint Grove Foreshore (Priority 2 Site)

The northern end of the reserve is uncleared and supports a remnant closed scrub community with emergent Tuarts (*Eucalyptus gomphocephalla*). The area is a recognised Bush Forever site (403).

Vested authority (s): Town of Mosman Park, Shire of Peppermint Grove, Town of Claremont, City of Nedlands.

Management strategies (refer to Table 4.7):

O, S, T, U, V, X, Y, AA, AB, AC.

Management recommendations:

- Improve the condition of vegetation in Bush Forever sites concentrating on the eradication of commonly occurring invasive species, including *Asparagus asparagoides, Euphorbia terracina, Romulea rosea, Ehrharta calycina, Lupinus cosentinii, Brassica tournefortii, Pelargonium capitatum and Arundo donax.* Less commonly occurring high risk species also requiring attention include *Cortaderia selloana, Lantana camara, Moraea flaccida, Typha orientalis and Watsonia meriana.*
- Extend invasive species control to whole of management zone for those species with a moderate to high invasive risk and seek to establish a coordinated and integrated invasive weed management approach for the whole of management area.
- Contain invasive species within poor condition areas, and in particular, ensure lawn from recreation areas is contained. Where foreshore pathways exist, seek to utilise these as effective grass barriers by replacing exotic grasses with local native species.
- Where the maintenance of grass peripheral to the river is considered desirable, seek to replace exotic species with local marine couch.
- Address degradation being caused by uncontrolled access in Bush Forever sites.
- Where remnant overstorey remains in parkland settings, for example, Point Resolution, promote regeneration by establishing no mow zones in the form of mulched beds under established trees. Where trees are scarce, promote planting of local native species to increase the structural complexity of reserves.
- Undertake revegetation using local native species along Claremont foreshore to increase connectivity between Bush Forever sites at Peppermint Grove and Point Resolution. Revegetation should seek to incorporate various structural layers and balance environmental outcomes while maintaining access to beaches via points of controlled access.
- Encourage use of local native species in all landscaping within parklands.
- Within the retained foreshore reserves of the City of Nedlands, support investigation of the feasibility of removing river walling and reinstating beach environments through works that seek to achieve multiple objectives for environmental outcome and recreation amenity.

Management Area 3 - Pelican Point and Matilda Bay

Priority 2

Description:

Includes Pelican Point Nature Reserve, the Matilda Bay recreation reserve, adjacent unwalled section of City of Perth foreshore to the north, and the City of Subiaco's JH Abraham Reserve to the south. Historically, dredging occurred within this management area and the spoil was used to reclaim areas of the foreshore. Retaining walls were built at JH Abrahams Reserve to protect the elevated and extended foreshore reserve that was created. Fortunately, no retaining walls were constructed to prevent erosion at Pelican Point. This enables the Point to be seasonally inundated, allowing a small wetland to persist and tidal flats to remain throughout the year within the Nature Reserve. The Matilda Bay section of the foreshore has been extensively modified and is a high use recreation area (Swan River Trust 1997).

Pelican Point Nature Reserve

Pelican Point Nature Reserve

Matilda Bay Reserve

Priority sites:

Site V.4: Pelican Point (Nature Reserve), Crawley (Priority 1 Site)

An ecologically important area including tidal flats, lake and marsh environment. The site is one of three significant wading bird habitats remaining on the Swan River, which collectively form the Swan Estuary Marine Park. The area is also a recognised Bush Forever site (402).

Vested authority (s): Department of Environment and Conservation, City of Subiaco.

Management strategies (refer to Table 4.7):

T, U, V, Y, AA, AB.

Management recommendations:

Focus on protection of the high conservation area of Pelican Point Nature Reserve with emphasis on eradication of invasive weed species, including *Arundo donax* and *Cortaderia selloana.* Ensure adequate weed control buffers are maintained between natural areas and recreation nodes. In particular, ensure exotic grass from maintained parkland does not encroach upon natural vegetation.

- Improve condition of vegetation through the expansion of good condition areas within the Nature Reserve.
- Within the broader management area, promote natural regeneration of overstorey remnant vegetation by establishing mulched beds as no mow zones under established trees. These can be complemented by plantings of local native understorey.
- Manage recreational usage to prevent degradation of environmental values.
- Address issues of dumped soil, rubbish and rubble.

Management Area 4 - Mounts Bay Road and Riverside Drive foreshores | **Low Priority**

Description:

This area is highly modified and has been repeatedly dredged, in-filled and retained behind various retaining structures over time to support significant public infrastructure. In addition to the busy roadways, the area provides a major pedestrian pathway linking Perth city with the University of Western Australia and the popular Matilda Bay recreation reserve. The area offers limited environmental value (Swan River Trust 1997).



Priority sites:

None.

Vested authority (s): City of Perth, Main Roads Western Australia.

Management strategies (refer to Table 4.7):

U, V.

Management recommendations:

- Promote the use of local native species in all landscaping works.
- Identify opportunities for establishment of sedge vegetation in front of retaining walls.
- Where appropriate, trial the use of native marine couch (*Sporobolus virginicus*) behind riverwalls as an alternative to exotic lawn. This species is likely to be more tolerant of estuarine overtopping.

Management Area 5 - Fremantle traffic bridge to the end of Blackwall Reach Parade (eastern foreshore) | **Low Priority**

Description:

Includes the shoreline between the Fremantle traffic bridge and the end of Blackwall Beach Parade, Bicton. The reserve is often narrow and supports infrastructure; includes designated high use recreation areas and playing fields away from the shoreline; or is degraded natural bush across relatively steep escarpments (Swan River Trust 1997).


Leeuwin Carpark


Norm McKenzie Park


Jerrat Drive

Vested authority (s): Town of East Fremantle, City of Melville.

Management strategies (refer to Table 4.7):

U, V.

Management recommendations:

- Consolidate rehabilitation effort at John Tonkin Park by managing public access and undertaking appropriate shore stabilisation and revegetation works that seek to provide a buffer of fringing vegetation with moderate structural complexity.
- Protect existing rehabilitation sites by eradicating exotic grass between native vegetation and foreshore pathways, for example, Norm McKenzie Reserve and Blackwall Beach Parade.
- Control invasive weed species across the management area by containing poor condition vegetation and eradicating species from good to moderate condition areas.
- Focusing on Blackwall Beach Parade, connecting areas of good condition vegetation through effective weed control, promotion of natural regeneration and revegetation. Revegetation should address breaches in fringing vegetation and serve to connect sites and widen the vegetation buffer to the existing pathway.
- Where remnant overstorey persists in grassed parklands, promote regeneration through the establishment of mulched no mow zones, which can be supplemented with understorey plantings of local native species.
- Provide designated beach access points to manage degradation caused by uncontrolled access and remove uncontrolled dingy storage from foreshore.

Management Area 6 - Point Walter and Alfred Cove — Priority 1

Description:

Defined by the boundary of Bush Forever site 331, including Blackwall Reach foreshore, Point Walter, the Alfred Cove Nature Reserve, adjacent bushland and Troy and Tompkins Parks, Attadale. From the 1840s to the turn of the century, the area was used for grazing and trees were felled for firewood and shingles. The large flat areas of Troy and Tompkins Parks are the result of extensive infilling for the disposal of domestic and building wastes, which were covered with sanitary land fill between 1952 and 1964 (Swan River Trust 1997).


Alfred Cove Nature Reserve


Alfred Cove Nature Reserve


Point Walter (west)

Priority sites:

Site V.1: Blackwall Reach, Point Walter, Alfred Cove and adjacent bushland, Bicton to Applecross (Priority 1 Site)

Alfred Cove 'A Class' Nature Reserve is managed by the Department of Environment and Conservation, and is part of the Swan Estuary Marine Park and a larger Bush Forever site. The nature reserve provides habitat for a rich and diverse assemblage of relatively undisturbed aquatic and terrestrial flora and fauna (CALM 1998). The Bush Forever site includes the remnant vegetation and high recreation use area of Point Walter and the expansive grassed parklands of Attadale Reserve, Troy Park and Tompkins Park, Attadale.

Vested authority (s): City of Melville, Department of Environment and Conservation.

Management strategies (refer to Table 4.7):

O, P, Q, T, U, V, W, X, Y, AA, AB, AC.

Management recommendations:

- Protect Alfred Cove Nature Reserve and the natural areas of Point Walter Reserve from degrading influences by:
  - eradicating invasive weeds, including *Brassica tournefortii, Ehrharta calycina, Euphorbia terracina, Lupinus cosentinii, Pelargonium capitatum, Romulea rosea, Typha orientalis, Moraea flaccida* and *Zantedeschia aethiopica.*
  - maintaining adequate weed control buffers between recreation areas and natural vegetation. In particular, ensure containment of exotic grass species associated with parklands.
  - revegetating breaches in shoreline vegetation to ensure structural integrity.
- Expand areas of good condition vegetation and seek to link these across the management area. In particular, seek opportunities to expand the peripheral vegetation across the narrow expanse of Alfred Cove Nature Reserve that runs parallel to Attadale Reserve, Troy Park and Tompkins Park.
- Protect nodes of remnant overstorey across Attadale Reserve and promote revegetation of understorey species. Where possible, provide linkage of these nodes to Alfred Cove Nature Reserve.
- Manage Point Walter to achieve multiple use objectives by concentrating recreational infrastructure within current areas and by seeking to improve the public amenity at these points. Within Point Walter Reserve, consider the potential for revegetation to be undertaken in nodes along Honour Avenue, with points of controlled access linking BBQ areas to the beach. Revegetation should be designed to offer shore protection where appropriate and to provide public amenity (e.g. shade and visual amenity) value.
- Where old growth remnant overstorey persists within the Point Walter reserve, consider incorporation of no mow zone mulch beds to promote natural regeneration.

Management Area 7 - Melville Beach Road to Bull Creek

Priority 2

Description:

This area includes the narrow linear foreshore of Melville Beach Road extending to Point Dundas and across to Point Heathcote, then along the Esplanade in Mount Pleasant to the Mount Henry Bridge. Much of the Melville foreshore was used for cattle and horse grazing from 1840 to the turn of the century. By the 1930s, fruit and vegetable production and milk and egg supply were well established agricultural activities. In the 1960s, the Applecross foreshore was filled in to cover the algal blooms that had the developed in the bay and the surrounding foreshores were severely degraded. The Attadale foreshore was also used as a rubbish dump for domestic waste and liquid effluent. The South Perth Yacht Club was relocated to Point Heathcote in 1962 and associated dredging and infilling to support activities and expansion has further modified the foreshores (Swan River Trust 1997).


Canning Beach Road


Point Heathcote


Jeff Joseph Reserve

Priority sites:

Site V.8: Point Heathcote Foreshore, Applecross **(Priority 2 Site)**
Point Heathcote foreshore is a recognised Bush Forever site (329) containing remnant vegetation within modified surroundings of mixed land use.

Site V.12: Canning Beach Road, Coffee Point, Applecross **(Priority 3 Site)**
Coffee Point is a flat embayment, with a small area of relatively good condition sedgeland established by the City of Melville. However, the sedgelands are isolated from other native vegetation and surrounded by exotic grassland.

Vested authority (s): City of Melville.

Management strategies (refer to Table 4.7):

O, P, R, S, T, U, V, W, X, Y, AA, AB, AC.

Management recommendations:

- Eradicate invasive weeds including *Asparagus asparagoides, Brassica tournefortii, Ehrharta calycina, Lupinus cosentinii* and *Watsonia meriana* from Heathcote Bush Forever site and extend control to remainder of management area, concentrating on good to moderate condition.
- Contain weed species within poor condition vegetation. In particular, ensure grasses from parklands do not encroach upon native vegetation. Where possible, use existing footpaths as effective grass control barriers and replace grass between native vegetation and the footpath with local native species such as Melville Beach Road, Jeff Joseph Reserve, Waylen Bay, and along the Esplanade, Mount Pleasant.
- Promote revegetation along embankments at Point Heathcote and extend along the Point Heathcote water ski area to stabilise banks and limit further shore retreat. Revegetation near the water ski area should be in nodes designed to maintain public access. The inclusion of tree and shrub species will increase the structural complexity and can be utilised as shade trees for recreation users.
- Address breaches in fringing vegetation along Melville Beach Road and Waylen Bay and link areas of revegetation along the Esplanade, Mount Pleasant. Increase the width and connectivity of the vegetative buffer across the management area.
- Where existing footpaths run parallel to the shore, use these as effective grass barriers. Narrow sections of grass between fringing native vegetation and the footpath should be replaced with local native species. Where the area widens to provide a recreational node with associated infrastructure and the maintenance of grass is desirable, these must be contained to prevent encroachment into natural vegetation.
- Promote regeneration of native overstorey species, and where absent incorporate plantings of local native tree species.

Management Area 8 - McCallum Park and Sir James Mitchell Parks — Low Priority

Description:

The area has a varied history, including use for Chinese market gardens from the 1880s, development of a polo club and racecourse in the 1890s, and dairy farms in the early 1900s. The majority of the area is included within Sir James Mitchell Park, which was established in 1950 and saw the area redeveloped for recreation, following the eviction of market gardeners. Today the area is a highly modified foreshore reserve maintained behind retaining structures and managed with a focus on recreational values (Swan River Trust and City of South Perth 2001).


Sir James Mitchell Park


Sir James Mitchell Park


McCallum Park

Priority sites:

None.

Vested authority (s): City of South Perth, Town of Victoria Park.

Management strategies (refer to Table 4.7):

T, U, V, AA, AB, AC.

Management recommendations:

- Encourage management to achieve multiple objectives, which seek to protect environmental values and improve these where compatible with management for recreation.
- Protect overstorey species and provide greater opportunity for regeneration.
- Incorporate fringing vegetation including dense sedge plantings where possible in front of walling.
- Trial use of local native couch as an alternative to exotic grasses especially in areas where overtopping is resulting in poor establishment of turf species.
- Promote extension of habitat around constructed wetland areas and improve connectivity to the river through nodes of revegetation.
- Integrate nodes of local native understorey vegetation, as appropriate, beneath established overstorey to rationalise the existing green space, reduce irrigation water usage and provide a habitat for native fauna.

Management Area 9 - Milyu Nature Reserve to Cloisters	Priority 1

Description:

The management area is narrow and confined by the Kwinana Freeway, which was established in the 1950s. Establishment of the freeway resulted in extensive shoreline infilling, resulting in encroachment into the river and loss of the extensive beach areas which had been popular picnic spots for local families. The area was also a popular swimming spot prior to construction of the freeway (Swan River Trust 1997).


Milyu Nature Reserve


Revegetation


View along freeway

Priority sites:

Site V.3: Milyu Nature Reserve, South Perth (Priority 1 Site)

Milyu is an 'A Class' Nature Reserve managed by the Department of Environment and Conservation and forms part of the Swan Estuary Marine Park. Although in close proximity to a major freeway, the sand flats, mud flats and beaches at Milyu provide good feeding and resting areas for both waders and other waterbirds, protected under international agreements with China and Japan (CALM 1998).

Vested authority (s): Department of Environment and Conservation, City of South Perth, Main Roads Western Australia and Department of Planning and Infrastructure.

Management strategies (refer to Table 4.7):

O, P, R, T, U, V, W, X, Y, AA, AB.

Management recommendations:

- As a priority, protect the vegetation of Milyu Nature reserve by eradicating invasive weed species, including *Eragrostis curvula, Hyparrhenia hirta, Lupinus cosentinii, Moraea flaccida, Romulea rosea and Typha orientalis.*
- In the short term, contain weeds within poor condition vegetation and eventually improve condition by expanding good condition areas. Long term management should result in a structurally complex vegetation buffer between Milyu and the Cloisters foreshore and Mount Henry bushland within Management Area 10.
- Focus on addressing breaches in good condition vegetation and along rehabilitated areas of the Management Area to protect the shoreline.
- Contain grasses associated with recreation use areas and eradicate from natural areas.
- Promote regeneration of shrub and tree species.

Management Area 10 - Point Fraser and Burswood Park to Clarkson Reserve and Adachi Park	Priority 2
Addressed within the Swan	

Management Area 16 - Cloisters to Clontarf Bay	Priority 1
Addressed within the Canning	

Management Area 17 - Bull Creek and Shelley-Rossmoyne foreshores to Riverton Bridge	Priority 2
Addressed within the Canning	

4.5.3 Swan (Zone 2)

Management priorities are outlined in Table 4.10 and displayed spatially within Figure 4.6 and Figure 4.7. Management areas are defined to provide a context for management and to facilitate application of management recommendations across a broader area to facilitate action for site linkage and promote action across management boundaries.

Table 4.10 Swan Zone: priority sites for management action aimed at protection, enhancement and management the fringing indigenous vegetation and habitat

Site	Location	Conservation or biodiversity value	Vegetation condition	Potential for deterioration				Priority ranking	Mgt area
				Invasive species	Degrading influences	Evidence of erosion	Overall score		
V.13	Bennett Brook, Eden Hill to West Swan.	High Bush Forever 305 EPP Wetland UFI 2590.	Good	High (42)	High (9)	High	High	1	Area 13
V.14	Swan River and Jane Brook, Ashfield (?) to upper Swan.	High Bush Forever 302 EPP Wetland UFI 2037, 2597, 2596?, 2593, 2594 and 2624.	Moderate	High (56)	High (11)	High	High	1	Area 13
V.15	Swan River saltmarshes, Bayswater / Maylands.	Moderate Bush Forever 313 Condition 1 veg = 14.6 ha.	Good	High (46)	High (8)	Moderate	High	1	Area 11
V.16	Swan River foreshore, Mount Lawley / Maylands.	Moderate Bush Forever 314 Condition 1 veg = 0.5 ha.	Moderate	High (34)	High (11)	Moderate	High	2	Area 10
V.17	Helena River, Helena Valley.	Moderate Bush Forever 215 National Park(?) 47880.	Moderate	High (51)	Moderate (5)	N/A	High	2	Area 15
V.18	Swan River Backwater, South Guildford.	Moderate Bush Forever 491.	Moderate	High (36)	Moderate (4)	N/A	High	2	Area 12
V.19	Walyunga National Park.	Moderate National Park (?) 2065.	Moderate	Moderate (21)	Low (3)	Moderate	Moderate	2	Area 14
V.20	Ashfield Flats, Bassendean / Ashfield.	Moderate Bush Forever 214 Condition 1 veg = 8.7 ha.	Moderate	Moderate (29)	Low (3)	Moderate	Moderate	2	Area 12
V.21	Avon Valley National Park.	Moderate National Park (?) 3019.	Moderate	Moderate (19)	Low (3)	Low	Low	2	Area 14

Site	Location	Conservation or biodiversity value	Vegetation condition	Potential for deterioration				Priority ranking	Mgt area
				Invasive species	Degrading influences	Evidence of erosion	Overall score		
V.22	SW of Garvey Park, Ascot.	Moderate EPP Wetland UFI 1921 Condition 1 veg = 5.0 ha.	Good	Low (3)	Low (2)	Moderate	Low	2	Area 12
V.23	Burswood Island.	Low Condition 1 veg = 2.9 ha.	Good	Moderate (17)	Low (1)	Moderate	Moderate	2	Area 10
V.24	Brighton Road, Rivervale (2.63 ha).	Low Condition 1 veg = 2.6 ha.	Good	Low (0)	Low (0)	Moderate	Low	3	Area 10
V.25	Peninsula Golf Course, Maylands (0.6 ha).	Low Condition 1 veg = 0.6 ha.	Good	Low (3)	Low (1)	High	Low	3	Area 10
V.26	Charles Paterson Park, Burswood (1.55 ha).	Low Condition 1 veg = 1.5 ha.	Good	Low (0)	Low (2)	Moderate	Low	3	Area 10
V.27	Ellis House, Bayswater (1.51 ha).	Low Condition 1 veg =1.5 ha.	Good	Low (13)	Low (0)	N/A	Low	3	Area 11
V.28	Bayswater Riverside Gardens, Bayswater (1.28 ha).	Low Condition 1 veg = 1.3 ha.	Good	Low (4)	Low (0)	Low	Low	3	Area 11
V.29	The Riverwalk, Ascot (0.69 ha).	Low Condition 1 veg = 0.7 ha.	Good	Low (0)	Low (0)	N/A	Low	3	Area 11

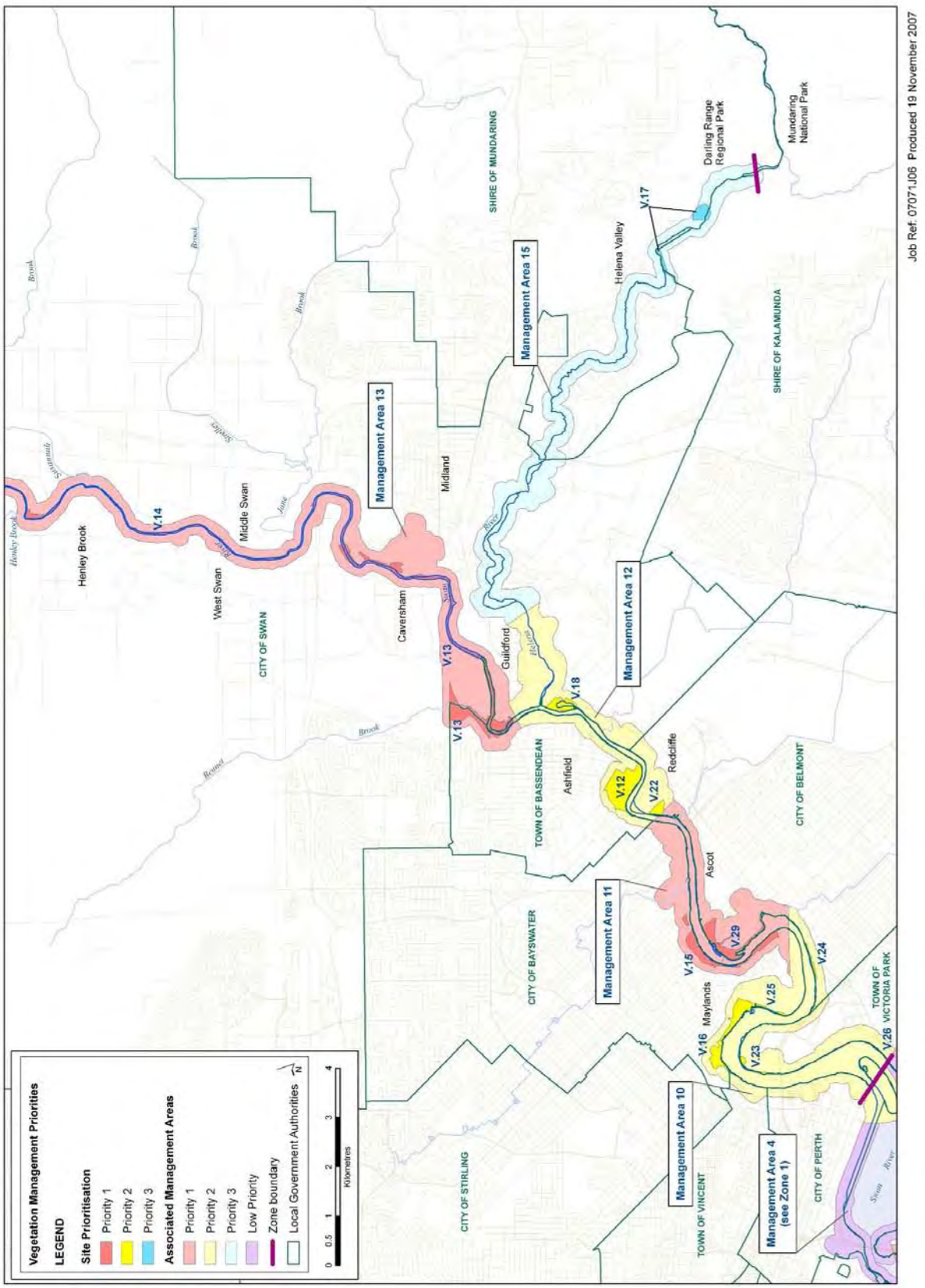


Figure 4.6 Lower Swan: priority areas for management action aimed at the protection, enhancement and management of fringing indigenous vegetation and habitat

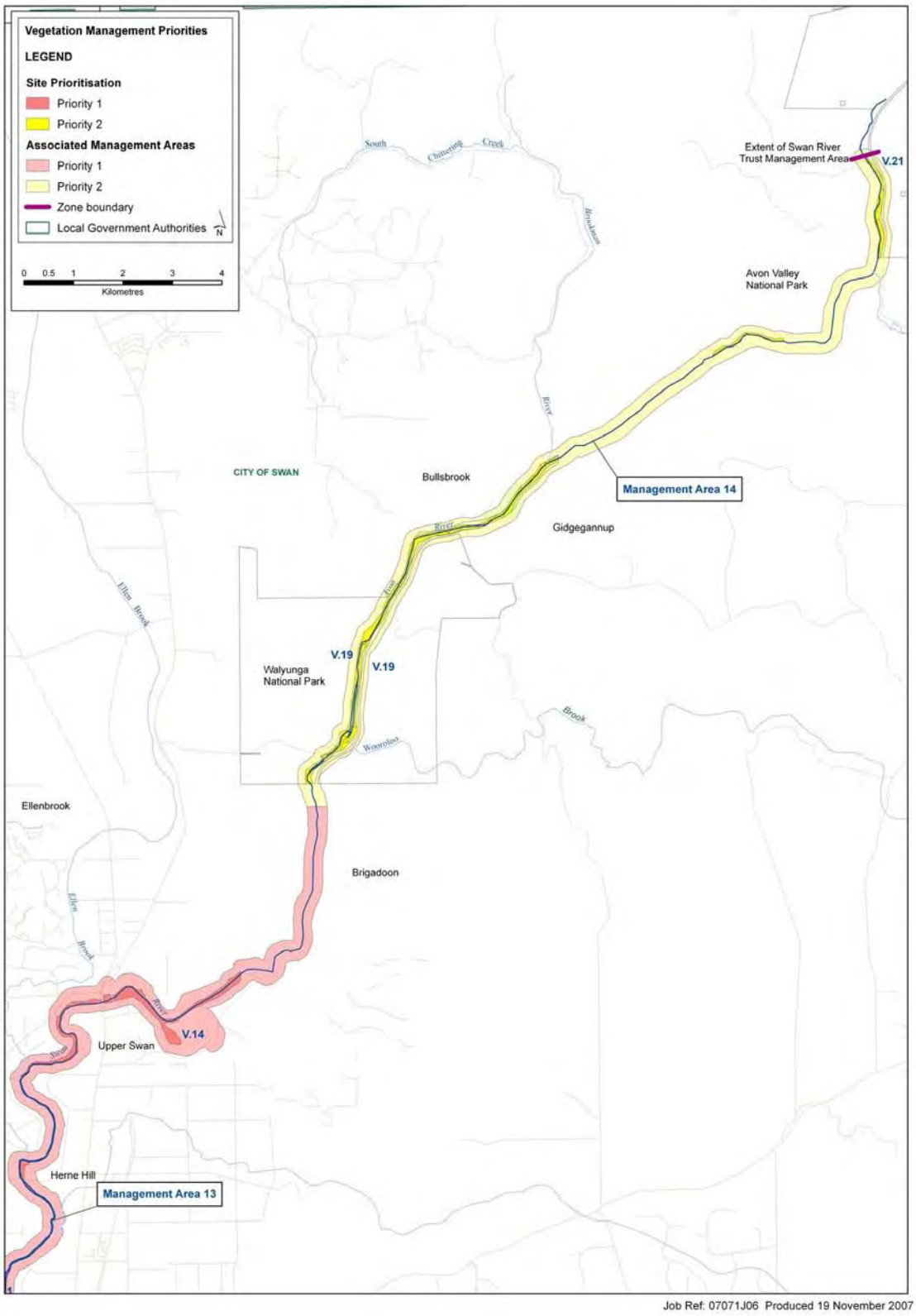


Figure 4.7 **Upper Swan: priority areas for management action aimed at protection, enhancement and management of fringing indigenous vegetation and habitat**

Management Area 10 - Point Fraser and Burswood Park to Clarkson Reserve and Adachi Park | **Priority 2**

Description:

Extensive landfill and intensive land use has removed or degraded much of the vegetation between Heirisson Island and Maylands Peninsula. Historically, this section of the river has been subject to various industrial and degrading land uses. Sewage settlement ponds operated at Burswood and Claisebrook as treatment works between 1906 and 1934. After World War II, a rubbish dump was established at Burswood and operated up until 1972. Rubble and rubbish infill were also extensively used in reclamation works within the area to create the foreshore reserves (Swan River Trust 1997).


Bardon Park (Bush Forever 314)


Berringa Park (Bush Forever 314)


Peninsula Golf Course


Rivervale


Burswood Island


Burswood Park

Priority sites:

Site V.16: Swan River Foreshore, Mount Lawley / Maylands (Priority 2)

Bush Forever site 314 contains Bardon Park, Berringa Park and a narrow area of foreshore reserve abutting the Maylands Peninsula Golf Course. Berringa Park to the north is of high conservation value. However, the site has been impacted by storm water drainage, which has altered the hydrology and salinity regime. Urban development and infilling have also significantly impacted on the site (Ecoscape 2000).

Site V.25: Peninsula Golf Course, Maylands (Priority 3)

A narrow section of foreshore containing good condition vegetation, which is directly next to the Swan River foreshore, and the Mount Lawley / Maylands Bush Forever site. Peninsula Golf Course backs onto the area.

Site V.23: Burswood Island (Priority 2)

Reclamation of Burswood Island has destroyed large amounts of the original saltmarsh vegetation (Thurlow *et al.* 1986), and future development of the site is proposed. While much of the broader area is degraded, good condition vegetation persists at the shore zone. Most of the sedges and rushes peripheral to the river and contributing to the high condition value were planted in the 1980s (Thurlow *et al.* 1986).

Site V.24: Brighton Road, Rivervale (Priority 3)

The Rivervale foreshore is characterised by steep riverbank escarpment that rises to 15 m above river level and support local and regionally significant plant species (Ecoscape 1995).

Site V.26: Charles Paterson Park, Burswood (Priority 3)

Burswood Park is managed and maintained by the Burswood Park Board. Most of the sedges and rushes in the shore zone were planted in the 1980s (Thurlow *et al.* 1986) following considerable shore modification, infilling and loss of large areas of saltmarsh vegetation.

Vested authority (s): City of Perth, Town of Vincent, City of Bayswater, City of Belmont, Town of Victoria Park, Burswood Park Board.

Management strategies (refer to Table 4.7):

O, P, Q, R, S, T, U, V, W, X, Y, AA, AB, AC.

Management recommendations:

Northern Bank

- As the highest priority, protect and expand good condition vegetation of the Swan River foreshore, Mount Lawley / Maylands Bush Forever site (314) by:
    - Eradicating invasive weed species from good and moderate condition areas, including *Arundo donax, Cortaderia selloana, Ehrharta calycina, Eragrostis curvula, Gomphocarpus fruticosus, Schinus terebinthifolia, Typha orientalis,* and *Watsonia meriana.*
    - Contain invasive weed species to poor condition areas.
    - Ensure all grassed recreation use areas are contained and not encroaching upon native vegetation. Replace lawn from between existing pathways and good condition vegetation with local native species and promote natural regeneration.
    - Address issues of dumped soil and rubble.
    - Investigate need for better controlled access to address issues of vegetation damage and trampling.
    - Manage impacts of stormwater management.
    - Manage, in conjunction with adjoining areas of good condition, vegetation along Peninsula Golf Course, Maylands.
- Progressively expand peripheral vegetation along Peninsula Golf Course Foreshore, Maylands. Undertake trials for plant establishment and shore stabilisation in this area of high erosion. Plan revegetation to increase structural complexity, provide adequate shore buffering against erosion and increase linkage to Maylands Foreshore Reserve and Clarkson Reserve. Provide controlled access to nodes for fishing and other activities, given current high recreation use.
- Progressively work to improve linkage of good condition vegetation within Bush Forever site with that of Banks Reserve Rehabilitation site, Town of Vincent and support the Town in continuing its effort down river in front of the old East Perth Power Station to link up with Claisebrook foreshore.
- Encourage increased connectivity of peripheral vegetation from Claisebrook to Point Fraser rehabilitation site, City of Perth.

Southern Bank

- Protect good condition vegetation at Rivervale, Burswood Island and Burswood Park by:
    - Eradicating invasive weed species, including *Cortaderia selloana, Ehrharta calycina, Schinus terebinthifolia, Typha orientalis,* and *Watsonia meriana* concentrated around Burswood Island.
    - Monitor for introduction of invasive weeds from surrounding areas into Rivervale and Burswood Park foreshore and eradicate before establishment of infestations.
    - Expand width of vegetation corridor where possible, including replacement of lawn between existing pathways and shore zone vegetation.

Overall

- Undertake integrated weed management of moderate and high risk invasive weeds across management area.
- Contain weeds within poor condition areas and address issue of grass encroachment from grassed recreation areas to native vegetation. Replace lawn from between existing pathways and native vegetation with local native species across management area.

Management Area 11 - Tranby foreshore and Ascot to Ashfield Parade and Garvey Park | **Priority 1**

Description:

Includes Baigup wetlands and Ascot Peninsula. Early land use in the area included market gardens. These were established along the Bayswater foreshore from as early as the 1850s, with some remaining until the 1970s. However, by the 1960s, industrial and urban land uses dominated. Over time, many streams and damplands have been drained, filled or rediverted. The Bayswater floodplain and Ascot were both used as dump sites for waste infill (Swan River Trust 1997).

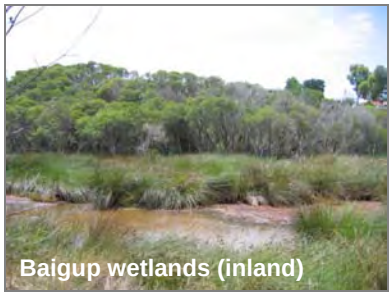

Ascot samphire flats


Ascot


Ascot sedgeland

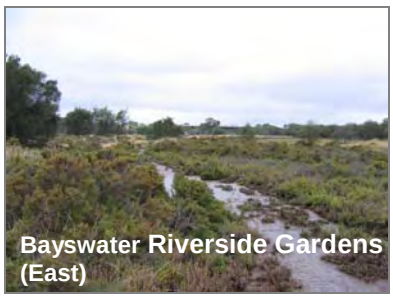

Tranby Foreshore


Baigup wetlands (riverside)


Baigup wetlands (inland)


Ellis House, Bayswater


Bayswater Riverside Gardens


Bayswater Riverside Gardens (East)

Priority sites:

Site V.15: Swan River saltmarshes, Bayswater / Maylands (Priority 1)

Bush Forever site 313 includes regionally significant vegetation at Baigup wetlands on the northern bank and Ascot samphire and sedgelands on the southern bank of the Swan River. Baigup reserve has been impacted by market gardening, polluted stormwater inputs and installation of a gas pipeline, and is a known site for acid sulphate soils. However, it remains an important habitat for waterbirds and other wetland fauna, as does Ascot across the river. The adjacent area of Ascot Island was formerly a landfill site, which is now used for passive recreation.

Site V.27: Ellis House, Bayswater (Priority 3)

Ellis House is part of Riverside Gardens landfill site. It is an area of native vegetation disconnected from the river and other areas of vegetation, and which was revegetated by the City of Bayswater.

Site V.28: Bayswater Riverside Gardens, Bayswater (Priority 3)

Riverside Gardens was a landfill site until 1981. Revegetation and weed control on the foreshore has been carried out by the City of Bayswater (Landscan 1995) and provides linkage to Eric Singleton Bird Sanctuary. The sanctuary was artificially created in 1976 and has opportunities for wildlife observation and education.

Site V.29: The Riverwalk, Ascot (Priority 3)

The Riverwalk is a narrow area of landscaped good condition vegetation associated with Ascot Island.

Vested authority (s): City of Bayswater, City of Belmont.

Management strategies (refer to Table 4.7):

O, P, Q, R, S, T, U, V, W, X, Y, AA, AB, AC.

Management recommendations:

- Highest priority for management is the protection and expansion of good condition vegetation within the Baigup wetlands and Ascot extent of Bush Forever site 313 by:
    - continuing to address acid sulphate soils at Baigup;
    - eradicating invasive weeds including *Ehrharta calycina, Eragrostis curvula, Euphorbia terracina, Lupinus cosentinii, Pelargonium capitatum, Schinus terebinthifolia, Typha orientalis, Rubus spp, Watsonia meriana* and *Zantedeschia aethiopica;*
    - investigating tree death at Ascot; and
    - addressing issues of dumped green waste, rubbish and rubble.
- Effectively manage high and moderate invasive weeds across all good to moderate condition vegetation and contain weeds within poor condition sites.
- Within the recreation nodes of Bush Forever site 313, for example, Tranby Foreshore, widen the peripheral vegetation buffer, realign the existing pathway to minimise shore erosion impacts from surface water flow and eradicate grass between the realigned path and the foreshore vegetation by densely planting with local native species. Seek opportunities to increase the structural complexity of the shore zone to protect against erosion. Rehabilitation should be designed to be compatible with continued foreshore access by providing nodes for controlled access where appropriate.
- Progressively seek to increase the connectivity between Baigup wetlands and sites of good condition vegetation at Bayswater Riverside Gardens. This should be achieved by balancing recreational values with opportunities for environmental improvement. The consolidation and widening of nodes of revegetation along AP Hinds Reserve is recommended. At these points, adequate containment of grasses from the adjoining parkland is required.
- The planting of more local native trees within foreshore reserves is recommended.
- The widening of corridors of fringing vegetation is strongly recommended, especially where reserves are limited to a single line of trees and where sedges are absent or discontinuous.
- Address breaches in shore zone sedges by infill planting to avoid further loss.

Management Area 12 - Ashfield Parade and Garvey Park to Success Hill and Fish Market Reserve, including Helena River to East Street | **Priority 2**

Description:

Much of the area was used for pasture for sheep and cattle up to the 1920s when an outbreak of an infectious cattle disease required the slaughter of stock and resulted in the collapse of many farms. Residential developments in West Guildford were established in the early 1900s and resulted in extensive clearing to make way for roads and gardens. Numerous damplands and streams were drained or rediverted to remove untidy vegetation and reduce problems with mosquitoes. River 'training' activities were also undertaken within the area to straighten meanders, and Ron Courtney Island was created between 1968 and 1973 by the cutting of a second river channel to reduce erosion at Ashfield Parade (Swan River Trust 1997).


Ashfield Flats


Garvey Park (South)


Swan River Backwater

Priority sites:

Site V.18: Swan River Backwater, South Guildford (Priority 2)

A section of good condition vegetation persists around the Swan River backwater, South Guildford. The area is of high biodiversity value and represents one of a limited number of backwaters remaining along the Swan River. Historically, many damplands were filled in for development or to eliminate problems with mosquitoes.

Site V.20: Ashfield Flats, Bassendean / Ashfield (Priority 2)

This floodplain area surrounding Ashfield Flats has been used for farming, orchards and as a tip site. Despite the degradation that has occurred, good quality vegetation remains within this regionally significant Bush Forever site (214). The endemic wetland and salt marsh communities provide a diversity of habitats for aquatic and terrestrial fauna.

Site V.10: SW of Garvey Park, Ascot (Priority 2)

Garvey Park was formerly connected to Ron Courtney Island prior to the cutting of the channel between 1968 and 1973, which was intended to alleviate erosion on the outer bank of the original channel bend at Ashfield Parade. Garvey Park is a popular recreational area along the Swan River and contains remnant vegetation of high conservation value (Ecoscape 1999). Coolgardie main drain living stream site is aligned between the recreational zone and remnant bushland. This area has been extensively revegetated by the community with local and state government support.

Vested authority (s): Town of Bassendean, City of Belmont, City of Swan, Western Australian Planning Commission.

Management strategies (refer to Table 4.7):

O, P, Q, R, S, T, U, V, W, X, Y, AA, AB, AC.

Management recommendations:

- Highest priority for management is to protect and extend the good condition vegetation within Ashfield Flats (214) and Swan River Backwater (491) Bush Forever sites, by:
  - Effectively managing invasive weeds including *Arundo donax, Asparagus asparagoides, Cortaderia selloana, Ehrharta calycina, Eragrostis curvula, Gomphocarpus fruticosus, Ipomoea indica, Lantana camara, Olea europaea, Oxalis pes-caprae, Ricinus communis, Romulea rosea, Rubus spp, Schinus terebinthifolia, Typha orientalis, Watsonia meriana* and *Zantedeschia aethiopica.*
  - Trialling techniques for shore stabilisation and revegetation at Ashfield Flats.
  - Where appropriate, avoid mowing or slashing of grasses under mature trees to promote natural regeneration. Where devoid of sufficient overstorey, promote the

dense planting of tree and shrub species and maintain the area with a grass specific herbicide to protect any supplementary understorey revegetation or naturally regenerating specimens.

- Manage stormwater impacts at Ashfield Flats to mitigate further site degradation.

- Across the management area, focus on increasing the fringing vegetation buffer, controlling high risk invasive species and providing access to the river foreshore with designated nodes for recreation activity to minimise impacts on vegetation.
- Within recreation reserves, contain grasses to avoid encroachment into native vegetation.
- Support opportunities to engage private landholders in foreshore management.

Management Area 13 - Success Hill Reserve to Walyunga National Park — Priority 1

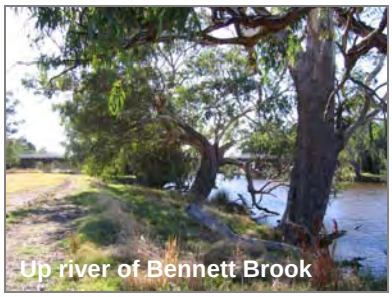
Description:

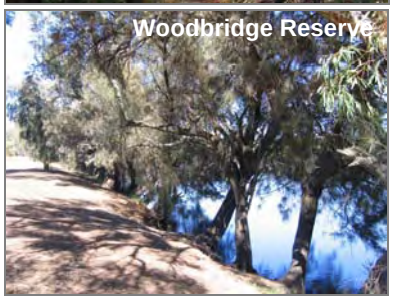
This is a large management area with a range of landforms, from steep embankments at Success Hill and near Midland to broad floodplains near Viveash and Caversham. The upper reaches of the Swan River become braided, and further upstream at Bells Rapids the river becomes a series of pools and rapids. The relatively rich soils of the mid and upper Swan meant land was in high demand following European settlement. Early activities included extensive sheep and cattle grazing, wheat crops, fruit and vegetable production and viticulture. The first vines were established as early as 1840 and were soon the favoured crop.

Historic Guildford was established in 1829 as an inland port and was one of the first three settlements of the Swan River Colony. To assist with navigation, river 'training activities' were undertaken to straighten meanders and the river was dredged from Guildford to Claisebrook (Swan River Trust 1997).

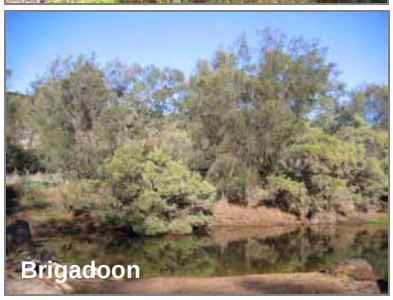

Success Hill Reserve


Bennett Brook


Up river of Bennett Brook


Woodbridge Reserve


Middle Swan


Brigadoon

Priority sites:

Site V.13: Bennett Brook, Eden Hill to West Swan (Priority 1)

The area is a regionally significant Bush Forever site containing remnant foreshore vegetation. Large areas have been modified by grazing, excavation for clay and drainage for urban development.

Site V.14: Swan River and Jane Brook, Ashfield to Upper Swan (Priority 1)

Scattered remnant vegetation remains along the Swan River within this generally very narrow Bush Forever Reserve. The area has been significantly impacted by grazing and continues to support stock, although over a much reduced area. Vineyards now occupy the majority of the floodplain.

Vested authority (s): City of Swan, Western Australian Planning Commission.

Management strategies (refer to Table 4.7):

O, P, Q, R, S, T, U, V, X, Y, AA, AB, AC.

Management recommendations:

- Protect all good condition areas by effectively controlling high risk invasive species.
- Increase the width of the vegetation buffer and establish vegetation where absent to provide shore protection and a habitat corridor for native fauna. Increase structural complexity within the vegetation corridor by ensuring revegetation includes species from a range of structural layers.
- Support opportunities to engage private landholders in foreshore protection and rehabilitation activities.
- Ensure adequate fencing to discourage animal grazing within the riparian zone.

Management Area 14 - Walyunga National Park to Moondyne Brook | **Priority 2**

Description:

Due to transport limitations and the relative unsuitability of the area for agriculture, this area was less intensively used for agriculture. However, cattle grazing without clearing has, resulted in the introduction of various invasive species and degraded the foreshore understorey. Today feral pigs are also a problem within the area. In 1965, the railway was constructed along the eastern bank requiring some valleys to be in-filled to allow for a straighter route (Swan River Trust 1997).


Walyunga NP


Walyunga NP


Avon Valley NP

Priority sites:

Site V.19: Walyunga National Park (Priority 2)

In 1969, the pastoral property was purchased by the state and the Walyunga National Park was established. The area provides a relatively natural river setting, although the understorey has been degraded by cattle grazing and introduced weeds and feral pigs threaten to further degrade the area.

Site V.21: Avon Valley National Park (Priority 2)

The Avon Valley National Park was declared in 1970. The Avon River runs centrally through the park and becomes turbulent and fast flowing during winter.

Vested authority (s): Department of Environment and Conservation.

Management strategies (refer to Table 4.7):

O, U, V, X, Y, AA, AB.

Management recommendations:

- Support the implementation of the Department of Water's lower Avon River Recovery Plan.
- Undertake extensive *Watsonia meriana* control program and effectively manage other high risk invasive weed species.
- Consolidate peripheral vegetation and undertake supplementary plantings to address breaches in shoreline vegetation around exposed sedimentary areas.
- Undertake direct seeding trials to reintroduce understorey species that have been lost as a result of clearing, grazing and weed invasion.
- Undertake effective feral pig control.
- Ensure adequate fencing to discourage animal grazing within the riparian zone.

Management Area 15 - Helena River from East Street to the lower Pipehead Dam | **Priority 3**

Description:

The Helena River has been dammed at the Mundaring Weir, resulting in its reduction to a series of pools and a dry exposed riverbed in summer. The broad river floodplain, which reaches 100-200 m, has been cleared extensively and used for pasture. Other significant land uses include jarrah logging and establishment of railway infrastructure to support the industry, and light industrial activities including skin drying sheds, stockyards, wholesalers and scrap yards. Midland Junction was established in 1886 to support rail transport to the Avon Valley, and in 1901 the State Government established its workshops parallel to the river in Midland (Swan River Trust 1997).


Lower Helena River


Mid Helena River


Upper Helena River (Darling Range)

Priority sites:

Site V.17: Helena River, Helena Valley Bush Forever Site

This Bush Forever site is part of the Goldfields water supply catchment areas and is of high conservation value for water quality, flora and fauna. It is in a relatively natural state with no major traffic arteries dissecting the valley.

Vested authority (s): City of Swan, Western Australian Planning Commission, Shire of Kalamunda, Shire of Mundaring, Department of Environment and Conservation.

Management strategies (refer to Table 4.7):

S, T, U, V, AA, AB, AC.

Management recommendations:

- Focus on protecting and expanding good condition vegetation within the Helena River Bush Forever site.
- Promote expansion of good condition vegetation to increase linkage and seek to increase the structural complexity and width of the habitat corridor.
- Effectively managing invasive weeds including *Arundo donax, Asparagus asparagoides, Echium plantagineum, Ehrharta calycina, Euphorbia terracina, Gomphocarpus fruticosis, Ipomoea indica, Lupinus cosentinii, Moraea flaccida, Olea europaea, Oxalis pes-caprae, Pelargonium capitatum, Ricinus communis, Romulea rosea, Rubus spp., Schinus terebinthifolia, Typha orientalis, Watsonia meriana*, and *Zantedeschia aethiopica*.
- Support opportunities to engage private landholders in foreshore protection and rehabilitation activities.
- Ensure adequate fencing to discourage animal grazing within the riparian zone.

4.5.4 Canning (Zone 3)

Management priorities are outlined in Table 4.11 and displayed spatially within Figure 4.8. Management areas are defined to provide a context for management and to facilitate application of management recommendations across a broader area to facilitate action for site linkage and promote action across management boundaries.

Table 4.11 Canning Zone: priority sites for management action aimed at the protection, enhancement and management of fringing indigenous vegetation and habitat

Site	Location	Conservation or Biodiversity Value	Vegetation Condition	Potential for deterioration				Priority ranking	Mgt Area
				Invasive species	Degrading influences	Evidence of Erosion	Overall Score		
V.30	Canning River Foreshore (Salter Point to Wilson, Clontarf).	High Bush Forever 333 EPP Wetland UFI 798 Condition 1 veg = 8.7 ha.	Good	High (37)	Moderate (4)	Moderate-High	High	1	Area 16
V.31	Canning River Regional Park and adjacent Bushland, Riverton to Langford.	High Bush Forever 224 EPP Wetland UFIs 1418, 2544, 2545, 2546, 2547, 2548 Condition 1 veg = 36 ha.	Moderate	High (65)	High (11)	Moderate	High	1	Area 18
V.32	Dallen Road Bushland, Southern River / Gosnells.	High Bush Forever 255 EPP Wetland UFIs 1499, 1603.	Moderate	High (31)	Moderate (4)	N/A	High	1	Area 21
V.33	Canning and Southern rivers, Beckenham to Kelmscott.	High Bush Forever 246 EPP Wetland UFIs 1482, 1483, 1484, 1485, 1486, 1487, 1488, 1489, 1490, 1514, 1246, 1557, 1558, 1559, 1560, 1515, 1629.	Poor	High (75)	High (12)	Moderate	High	1	Area 19
V2 (Z1)	Mount Henry Bushland, Salter Point.	High Bush Forever 227 EPP Wetland UFI 798 Condition 1 veg = 2.2 ha.	Good	Moderate (26)	Moderate (4)	Moderate	Moderate	1	Area 16
V.34	Yagan Wetland and Adjacent Bushland, Rossmoyne to Bull Creek.	Moderate Bush Forever 338 Condition 1 veg = 0.2 ha.	Moderate	High (39)	Moderate (5)	Low	Moderate	2	Area 17
V.35	Collins Road, Roleystone **.	Low Condition 1 veg = 1.8 ha.	Good	Moderate (23)	Low (0)	N/A	Moderate	2	Area 20
V.36	Shelley Rossmoyne Foreshore Park-Tuscan Street, Rossmoyne.	Low Condition 1 veg = 1.0 ha.	Good	Low (6)	Low (1)	Moderate	Low	3	Area 17
V.37	Shelley Rossmoyne Foreshore-W of Shelley Bridge, Shelley.	Low Condition 1 veg = 1.8 ha.	Good	Low (10)	Low (0)	Moderate	Low	3	Area 17
V.38	Croyden Road, Roleystone.	Low Condition 1 veg = 2.0 ha.	Good	Low (11)	Low (0)	N/A	Low	3	Area 20

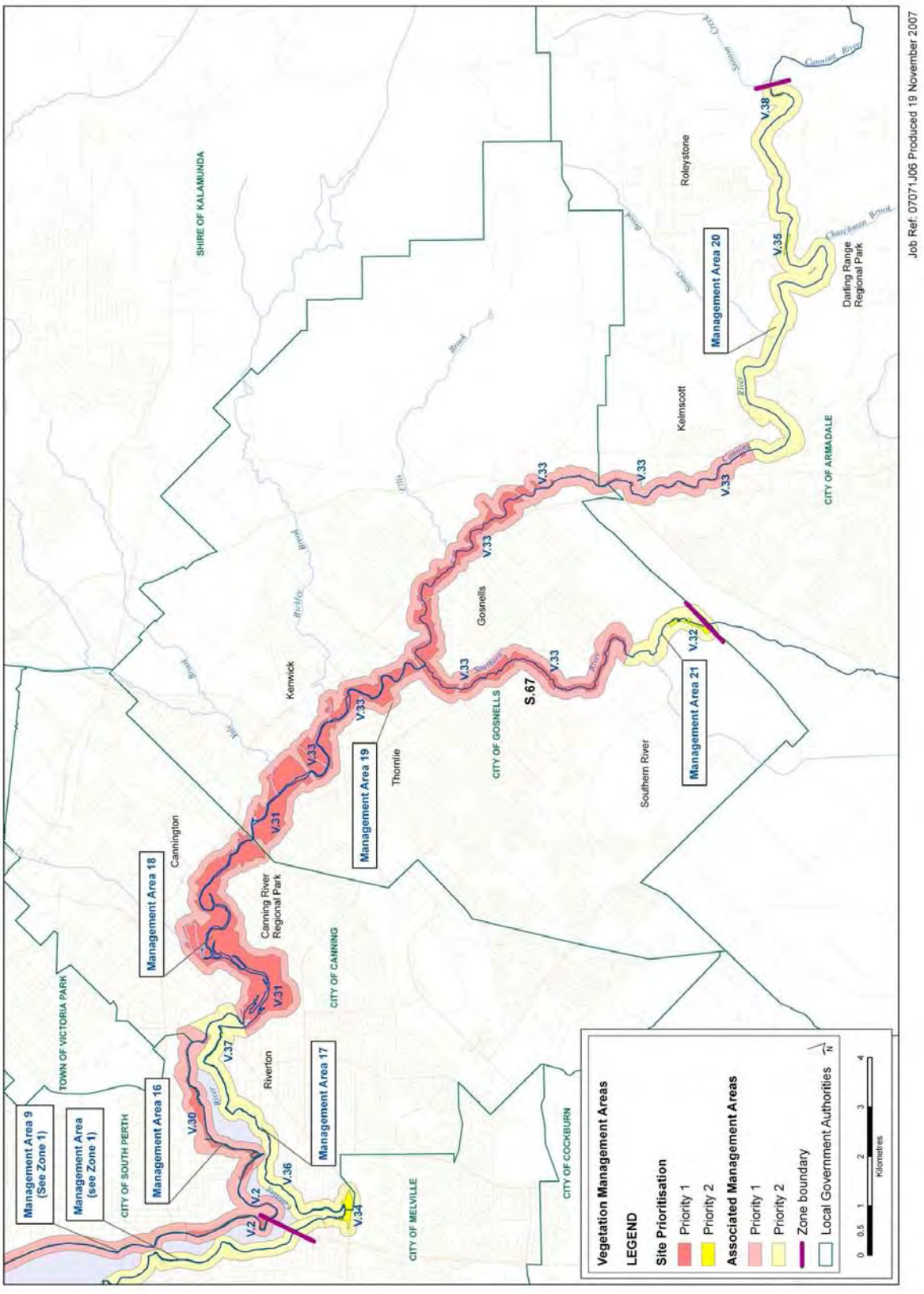


Figure 4.8 Canning Zone: priority areas for management action aimed at protection, enhancement and management of fringing indigenous vegetation and habitat

Management Area 16 - Cloisters to Clontarf Bay — Priority 1

Description:

This management area covers the spatial extent of the two regionally significant Bush Forever sites and is dominated by good condition vegetation. Bushland south of Manning Road was relatively untouched until the early 1900s. In the 1920s, a tramline was opened to Como allowing holiday makers to access the beach between Como and Mount Henry. In 1935, the Christian Brothers bought a number of lots and moved Aquinas College to the peninsula. Previous activities including a quarry, rifle range and golf course, remain visible today. The Christian Brothers also established Clontarf Boys' home in 1901 and undertook extensive clearing from Manning Road to the foreshore. Natural vegetation was replaced by buildings, gardens, orchards, paddocks and playing grounds. Salter Point remained relatively undisturbed until the 1950s building boom (Swan River Trust 1997).


Cloisters west


North Mount Henry


Andrew Thomson Conservation Reserve

Included sites:

Site V.2: Mount Henry Bushland, Salter Point (Priority 1)

In the early 1900s, the area was a popular camping and swimming spot. Permanent camps were set up during the Depression years of the late 1920s to 1930s as families evicted from their homes took refuge under the paperbarks at Cloister. Various land use associated with the development of Aquinas College resulted in vegetation clearing, however the most significant impact near the peninsula has been construction of the Narrows Bridge (opened in 1959) and freeway extensions (1977). Despite variable land uses and degradation, considerable remnant vegetation remains. The area is recognised as high regional conservation value, with management plans and rehabilitation proceeding (Ecoscape 2004).

Site V.30: Canning River Foreshore (Salter Point to Wilson, Clontarf) (Priority 1)

In the early 1900s Clontarf was established by transporting building materials across the river by barge. Extensive clearing of native vegetation was undertaken and the foreshore area was used as a rubbish dump. Landfill was used to fill and raise wetland areas to create ovals and to protect the built environment from inundation. The predominant land use at Salter Point is residential (Swan River Trust 1997).

Vested authority (s): City of South Perth, Main Roads Western Australia, Aquinas College, Christian Brothers and Water Corporation.

Management strategies (refer to Table 4.7):

O, P, R, S, T, U, V, W, X, Y, AA, AB, AC.

Management recommendations:

- Protect and expand good condition vegetation within this regionally significant management area by:
  - Effectively managing invasive weeds including *Arundo donax, Cortaderia selloana, Ehrharta calycina, Eragrostis curvula, Euphorbia terracina, Lagurus ovatus, Lantana camara, Leptospermum laevigatum, Olea europaea, Pelargonium capitatum, Ricinus communis, Schinus terebinthifolia, Typha orientalis* and *Watsonia meriana.*
  - Ensuring adequate delineation between grassed recreation areas and natural vegetation is maintained to avoid exotic grass encroachment. Where the inclusion of grass is desirable within the foreshore reserve, promote the use of the local native marine couch.
  - Increasing the width of the riparian corridor and increasing the structural complexity in nodes where trees and shrubs have been removed.
  - Undertaking infill planting to address breaches in sedge vegetation, allowing designated points for managed access to the river for recreation activity. In particular, provide adequate controlled access to the river for the Curtin Rowing Club site at Salter Point and rehabilitate degraded riparian vegetation within the immediate vicinity.
  - Addressing localised areas of high erosion along both sides of Salter Point.
  - Investigate causes of crown death at north Mount Henry.

Management Area 17 - Bull Creek and Shelley-Rossmoyne Foreshore to Riverton Bridge | **Priority 2**

Description:

The Shelley-Rossmoyne Foreshore is very narrow with residential roads and development occurring within metres of the river. During the 1850s, convicts and ticket of leave men were employed to clear a channel in the river and to build a pole and wattle fence to transport and guide jarrah logs downstream. Vegetation was cleared for the establishment of camp sites and for use in construction work. In later years, the river was dredged in this vicinity and the spoil used to extend the foreshore and raise low lying areas for development (Swan River Trust 1997).


Bull Creek


Shelley-Rossmoyne foreshore (Tuscan Street)


Shelley-Rossmoyne foreshore (West of Shelley Bridge)

Priority sites:

Site V.34: Yagan Wetland and adjacent bushland from Rossmoyne to Bull Creek (Priority 2)
The area contains some fringing woodland vegetation and has been the focus for considerable restoration effort. However, the site is threatened by various invasive species, and an increase in boat moorings in the Bull Creek inlet has resulted in greater recreational activity with the potential to degrade the foreshores.

Site V.36: Shelley-Rossmoyne Foreshore, Tuscan Street, Rossmoyne (Priority 3)
A narrow foreshore area of good condition vegetation, which has been rehabilitated and is maintained by the Canning River Residents Environmental Protection Association and the City of Canning.

Site V.37: Shelley-Rossmoyne Foreshore, West of Shelley Bridge, Shelley (Priority 3)
A narrow foreshore area of good condition vegetation, which has been rehabilitated and is maintained by the Canning River Residents Environmental Protection Association and the City of Canning.

Vested authority (s): City of Melville, City of Canning.

Management strategies (refer to Table 4.7):

P, R, S, T, U, V, W, X, Y, AA, AB, AC.

Management recommendations:

- Protect and expand good condition vegetation by:
  - Effectively managing invasive weeds including *Arundo donax, Cortaderia selloana, Ehrharta calycina, Eragrostis curvula, Euphorbia terracina, Lagurus ovatus, Lantana camara, Pelargonium capitatum, Ricinus communis, Rubus spp., Schinus terebinthifolia, Typha orientalis* and *Watsonia meriana*, which are concentrated around Yagan wetland.
  - Ensuring adequate delineation between grassed recreation areas and natural vegetation is maintained to avoid exotic grass encroachment. Where possible, confine grass to recreation nodes with supporting infrastructure and eliminate from between pathways and existing peripheral vegetation.
  - Increasing the width of the riparian corridor to correspond with grass removal.
  - Undertaking infill planting to address breaches in vegetation, allowing designated points for managed access to the river for recreation activity. Where appropriate, use bioengineering solutions to address localised areas of erosion along the Shelley-Rossmoyne Foreshore.
  - Promote the use of fishing platforms as focal points for responsible recreational fishing.
  - Address issues of vegetation trampling and degradation resulting from inappropriate pedestrian movement to boat moorings at Bull Creek.
  - Address impacts from stormwater management structures.

Management Area 18 - Canning River Regional Park — Priority 1

Description:

Farming in the area dates back as far as 1840. By the 1890s, a number of orchards and farms were established and several dairies were operational by the 1920s and 1930s. Market gardens were also established and were an important supply of fresh fruit and vegetables. Around the 1890s, brickworks were established at Wilson Park with clay pits nearby. Mason's Landing was established as a docking point in the 1860s for timber to be loaded onto barges for transport to Fremantle, after having been transported by rail from Kalamunda. The area was also a hub for small industries servicing the demand of the saw pits and included blacksmithing, wheel wrighting and building. The river was desnagged in 1924 and sunken barges also removed. The Kent Street Weir was completed in 1927 to retain freshwater and block saltwater intrusion. It was made more efficient in 1940 after construction of the Canning Dam meant less freshwater was available for extraction (Swan River Trust 1997).



Priority sites:

Site V.31: Canning River Regional Park and adjacent bushland from Riverton to Langford

The park supports a diversity of habitats from estuarine to freshwater riverine and modified floodplain woodlands. Despite various past land uses, the area retains the best condition vegetation within the Swan Canning system and is recognised as a regionally significant Bush Forever site.

Vested authority (s): Department of Environment and Conservation, City of Canning, Christian Brothers and Water Corporation.

Management strategies (refer to Table 4.7):

O, P, S, T, U, V, Y, Z, AA, AB, AC.

Management recommendations:

- Protect and expand good condition vegetation by:
  - Effectively managing invasive weeds including *Anredera cordifolia*, *Arundo donax, Asparagus asparagoides, Colocasia esculenta, Cortaderia selloana, Echium plantagineum, Ehrharta calycina, Eragrostis curvula, Ferraria crispa, Gomphocarpus fruticosis, Ipomoea indica, Juncus acutus, Lagurus ovatus, Moraea flaccida, Olea europaea, Oxalis pes-caprae, Pelargonium capitatum, Ricinus communis, Rubus spp., Schinus terebinthifolia, Tamarix aphylla, Typha orientalis, Watsonia meriana*, and *Zantedeschia aethiopica*.
  - Ensuring adequate delineation between grassed recreation areas and natural vegetation. Where grasses are established under large mature trees or in association with rehabilitation sites, ensure grass management is compatible with protection of native species and is not detrimental to tree species regeneration.
  - Undertaking infill planting to address breaches in vegetation along the shore line, allowing designated points for managed access to the river.
  - Promote connectivity of rehabilitation effort on the floodplain and around associated wetlands to the riparian zone of the shore line.
  - Promote the use of designated areas as focal points for responsible recreational fishing and canoe launching and address issues of vegetation trampling.
  - Address issues of dumped soil, rubble and rubbish and eradicate feral animals.
  - Consider establishing the Canning River Regional Park as a no or low wash zone and prevent the use of power boats within its boundaries (except for river management activities).
  - Address illegal motorbike use in the park, which is resulting in environmental damage and threatens public safety.

Management Area 19 - Nicholson Road Bridge to Fancote Park (Canning River) and Margaret Street (Southern River) | **Priority 1**

Description:

The Canning River becomes a narrow shallow channel as it approaches the confluence of the Southern River. Past the confluence, it becomes increasingly incised, forming almost vertical clayey embankments towards the top end of the management area. The Southern River is very shallow with broad floodplains. Historic land use along the Canning includes orchards, poultry farms, and small dairies. Light industrial and commercial land uses are common along the Canning River, with use for horticulture, grazing and orchards remaining further up river. Much of the land originally cleared for agricultural purposes has been redeveloped for residential purposes. In the upper reaches, the foreshore reserves become extremely narrow. Historically, the focus on the Southern River has been grazing and horse agistment, with residential development in the downstream sections appearing from the 1920s. The demand for development has increased in recent years resulting in significant floodplain modifications (Swan River Trust 1997).



Priority sites:

Site V.33: Canning and Southern Rivers from Beckenham to Kelmscott (Priority 1)

While infilling has been extensive to allow for development of sites, a number of important dampland areas remain. These damplands, together with the remnant overstorey vegetation that remains, are considered regionally significant and the entire management area is a recognised Bush Forever site.

Vested authority (s): City of Gosnells, City of Armadale.

Management strategies (refer to Table 4.7):

O, Q, R, S, T, U, V, X, Y, AA, AB, AC.

Management recommendations:

- Focus effort on protecting and progressively expanding good condition vegetation to increase linkage between sites.
- Effectively managing invasive weeds including *Anredera cordifolia, Arundo donax, Asparagus asparagoides, Cardiospermum grandiflorum, Cortaderia selloana, Echium plantagineum, Ehrharta calycina, Eragrostis curvula, Euphorbia terracina, Gomphocarpus fruticosis, Hyparrhenia hirta, Ipomoea indica, Lantana camara, Leptospermum laevigatum, Lonicera japonica, Moraea flaccida, Olea europaea, Oxalis pes-caprae, Pelargonium capitatum, Pennisetum setaceum, Ricinus communis, Romulea rosea, Rubus spp., Schinus terebinthifolia, Solanum linnaeanum, Typha orientalis, Watsonia meriana*, and *Zantedeschia aethiopica*. Prioritise species based on their immediate threat to good condition vegetation based on proximity and invasive potential. Contain invasive weed species within poor condition vegetation by ensuring adequate weed control buffers between sites.
- Ensure adequate delineation between grassed recreation areas and natural vegetation is maintained to avoid exotic grass encroachment. Where grasses are established under large mature native floodplain trees or in association with rehabilitation sites, ensure grass management is compatible with protection of native species and is not detrimental to tree species regeneration.
- Focus revegetation effort on re-establishment of understorey vegetation complexity and widening of habitat corridors.
- Support opportunities to engage private landholders in foreshore protection and rehabilitation.
- Address issues of dumped green waste, rubbish and rubble.
- Address issues of vegetation trampling and damage by providing adequate and appropriate alternatives for foreshore access within recreation areas.
- Ensure adequate fencing to discourage animal grazing within the riparian zone.

Management Area 20 - Fancote Park to Stinton Creek — Priority 2

Description:

The river becomes increasingly restricted by the surrounding bedrock, which has limited the range and intensity of land use. The area has become increasingly residential as numerous rural properties have been redeveloped as suburban blocks from 1965 onwards. Some small orchards and grazing paddocks remain. The foreshore reserve through this area is extremely narrow (Swan River Trust 1997).



Priority sites:

Site V.35: Collins Road, Roleystone (Priority 2)

A relatively small area of good condition vegetation.

Site V.38: Croyden Road, Roleystone (Priority 3)

A relatively small area of good condition vegetation.

Vested authority (s): City of Armadale.

Management strategies (refer to Table 4.7):

O, T, U, V, AA, AB, AC.

Management recommendations:

- Focus effort on protecting and progressively improving vegetation condition within the Dallen Road Bushland Bush Forever site within Southern River / Gosnells.
- Effectively managing invasive weeds including *Asparagus asparagoides, Ehrharta calycina, Gomphocarpus fruticosis, Moraea flaccida, Ricinus communis, Romulea rosea, Schinus terebinthifolia, Solanum linnaeanum, Watsonia meriana*, and *Zantedeschia aethiopica*.
- Support opportunities to engage private landholders in foreshore protection and rehabilitation activities.
- Ensure adequate fencing to discourage animal grazing within the riparian zone.

Management Area 21 - Margaret Street (Southern River) to Allen Road Crossing | **Low Priority 2**

Description:

Historically, the area has been dominated by agricultural activity, in particular grazing and horse agistment. However, increasing residential pressures are occurring along the Southern River (Swan River Trust 1997).

Priority sites:

Site V.32: Dallen Road Bushland, Southern River Gosnells (Priority 2)

A relatively small area of good condition vegetation is contained within this Bush Forever site.

Vested authority (s): City of Armadale.

Management strategies (refer to Table 4.7):

T, U, V, X, Y, AA, AB, AC.

Management recommendations:

- Focus effort on protecting and progressively extending good condition vegetation.
- Effectively manage invasive weeds including *Asparagus asparagoides, Eragrostis curvula, Echium plantagineum, Hyparrhenia hirta, Lonicera japonica, Olea europaea, Rubus spp., Watsonia meriana*, and *Zantedeschia aethiopica*.
- Ensure adequate fencing to discourage animal grazing within the riparian zone.

4.6 Summary: Priority Sites for Management

There are large areas of foreshore that are in need of management. In order to focus action in key areas, a system of prioritisation was undertaken (see sections 4.3 – Riverbanks and Shorelines; and 4.5 Vegetation). Table 4.12 shows area based priorities for management that have been identified and grouped into broader management areas based on land management boundaries and the similarity of management response.

Table 4.12 Management priorities within each zone

Zone	Management area	Riverbanks and shorelines priority	Vegetation priority
Estuary Foreshore (Zone 1)	1. Fremantle traffic bridge to Rocky Bay, North Fremantle (western foreshore)	**Priority 2** S.1 Lower Fremantle to Chidley Point	**Priority 3** V.10 Gilbert Fraser Reserve, North Fremantle V.11 Rocky Bay, North Fremantle
	2. Rocky Bay to JH Abrahams Reserve, Subiaco	**Priority 2** S.1 Upper Fremantle to Chidley Point S.5 Point Resolution to Nedlands Foreshore S.6 Nedlands foreshore to Pelican Point (minus Pelican Point section) Priority 3 S.2 Chidley Point to Keanes Point S.3 Keanes Point to Claremont S.4 Claremont Cliffs to Point Resolution	**Priority 2** V.5 Point Resolution Reserve, Dalkeith (Bush Forever site) V.6 Chidley Point and adjacent Bushland, Mosman Park (Bush Forever site) V.7 Minim Cove, Mosman Park (Bush Forever site) V.9 Peppermint Grove foreshore (Bush Forever site)
	3. Pelican Point and Matilda Bay	**Priority 2** S.6 Nedlands foreshore to Pelican Point (minus Nedlands foreshore section) Priority 3 S.7 Pelican Point to UWA Boat Club (Matilda Bay)	**Priority 2** V.4 Pelican Point, Crawley (Bush Forever site)
	4. Mounts Bay Road and Riverside Drive foreshores	**Priority 1** S.8 UWA Boat Club to Narrows S.9 Narrows to Barrack Square S.10 Barrack Square to Point Fraser	**Low Priority**
	5. Fremantle traffic bridge to the end of Blackwall Reach Parade (eastern foreshore)	**Priority 2** S.1 Fremantle to Chidley Point	**Low Priority**
	6. Point Walter and Alfred Cove	**Priority 1** S.11 Point Walter Reserve (end of Blackwall Reach Parade to Stock Road) Priority 2 S.14 South Lucky Bay (Cunningham Street) to Point Dundas (limited to section directly abutting the Swan Estuary Marine Reserve) Priority 3 S.12 Point Walter to Alfred Cove S.13 Alfred Cove to South Lucky Bay (Cunningham Street)	**Priority 1** V.1 Blackwall Reach, Point Walter, Alfred Cove and adjacent bushland, Bicton to Applecross (Bush Forever site)

	7. Melville Beach Road to Bull Creek	**Priority 2** S.14 South Lucky Bay (Cunningham Street) to Point Dundas (section directly outside the Swan Estuary Marine Reserve) S.16 Applecross Jetty to Point Heathcote S.18 Coffee Point to Canning Bridge S.19 Canning Bridge to Mount Henry Bridge Priority 3 S.15 Point Dundas to Applecross Jetty S.17 Point Heathcote to Coffee Point	**Priority 2** V.8 Point Heathcote foreshore, Applecross (Bush Forever site) V.12 Canning Beach Road, Applecross
	8. McCallum Park and Sir James Mitchell Parks	**Priority 1** S.22 Richardson Street to north end of PWC area (upper section) Priority 2 S.23 North end of Narrows PWC area to Mends Street S.24 Mends Street to Causeway	**Low Priority**
	9. Milyu Nature Reserve to Cloisters	**Priority 1** S.21 Como foreshore S.22 Richardson Street to north end of PWC area (lower section) Priority 2 S.20 Mount Henry Bridge to Canning Bridge (upper section)	**Priority 1** V.3 Milyu Nature Reserve, South Perth
Swan River (Zone 2) Includes the lower Avon River and Helena River	10. Point Fraser and Burswood Park to Clarkson Reserve and Adachi Park	**Priority 1** S.30 Balbuck Way Water Ski Area (west bank, formerly Goodwood Parade) Priority 2 S.26 Causeway to Claisebrook S.28 East Perth Power Station and Banks Reserve S.32 Cracknell Park to Ascot Water entrance channel Priority 3 S.25 Heirisson Island S.27 Causeway to Windan Bridge S.29 Bardon Park S.31 Maylands Peninsula – golf course to Clarkson Reserve	**Priority 2** V.16 Swan River Foreshore, Mount Lawley / Maylands (Bush Forever site) V.23 Burswood Island Priority 3 sites: V.24 Brighton Road, Rivervale V.25 Peninsula Golf Course foreshore, Maylands V.26 Charles Preston Park, Burswood
	11. Tranby Foreshore and Ascot to Ashfield Parade and Garvey Park	**Priority 1** S.34 Tranby on Swan (including Bath Street Reserve) S.35 Ascot Racecourse S.36 Claughton Reserve (Katanning Street Boat Ramp) (lower section) Priority 2 S.33 Hardey Road Reserve	**Priority 1** V.15 Swan River saltmarshes, Bayswater / Maylands (Bush Forever site) Priority 3 sites: V.27 Ellis House, Bayswater V.28 Bayswater Riverside Gardens, Bayswater V.29 The Riverwalk, Ascot

	12. Ashfield Parade and Garvey Park to Success Hill and Fish Market Reserve, including Helena River to East Street	**Priority 1** S.36 Claughton Reserve (Katanning Street Boat Ramp) (upper section) S.37 Ashfield Parade / Ron Courtney Island / Garvey Park Priority 2 S.39 Sandy Beach Reserve to Helena River confluence (both banks) S.38 Sandy Beach Reserve Priority 3 S.40 Helena / Swan confluence (including Point Reserve) S.41 Lower Helena River	**Priority 2** V.18 Swan River Backwater, South Guildford (Bush Forever site) V.20 Ashfield Flats, Bassendean / Ashfield (Bush Forever site) V.22 Southwest of Garvey Park, Ascot
	13. Success Hill Reserve to Walyunga National Park	**Priority 1** S.43 Success Hill S.46 S.47 Priority 2 S.42 Fish Market Reserve S.45 St Vincent's Hospital foreshore to Woodbridge Riverside Park (including St Charles Seminary) S.48 John George Walk Trail (Blackadder Creek to Reg Bond Reserve) S.50 Middle Swan Bridge Reserve S.54 Bells Rapids Park to Bells Rapids Priority 3 S.44 St Vincent's Hospital foreshore S.49 Midland Brick foreshore (private) S.51 Middle Swan Bridge Reserve to Susannah Brook confluence S.52 Ellen Brook confluence and All Saints Church S.53 Upper Swan Bridge and Pullman Park	**Priority 1** V.13 Bennett Brook, Eden Hill to West Swan (Bush Forever site) V.14 Swan River and Jane Brook, Ashfield to Upper Swan (Bush Forever site)
	14. Walyunga National Park to Moondyne Brook	**Low Priority**	**Priority 2** V.19 Walyunga National Park V.21 Avon Valley National Park
	15. Helena River from East Street to the lower Pipehead Dam	**Low Priority**	**Priority 3** Except for: V.17 Helena Valley Bush Forever site is of **Priority 2** status
Canning River (Zone 3) Includes the Southern River	16. Cloisters to Clontarf Bay	**Priority 3** S.20 Mount Henry Bridge to Canning Bridge (lower section) Priority 2 S.56 Salter Point S.55 Mount Henry and Aquinas Bay Priority 3 S.57 Salter Point West (Salter Point to Curtin University Rowing Club) S.58 Clontarf to Shelley Bridge	**Priority 1** V.2 Mount Henry bushland, Salter Point (Bush Forever site) V.30. Canning River Foreshore, Salter Point to Wilson / Clontarf (Bush Forever site)

	17. Bull Creek and Shelley-Rossmoyne Foreshores to Riverton Bridge	**Priority 1** S.59 Leach Highway offramp (Centenary Avenue) Priority 2 S.60 Bull Creek S.61 Shelley-Rossmoyne Foreshore (Bull Creek to Shelley Bridge) S.62 Shelley Bridge to Riverton Bridge (both banks)	**Priority 2** V.34 Yagan Wetland and adjacent bushland from Rossmoyne to Bull Creek (Bush Forever site) Priority 3 V.36 Shelley-Rossmoyne Foreshore, Tuscan Street, Rossmoyne V.37 Shelley-Rossmoyne Foreshore, West of Shelley Bridge, Shelley
	18. Canning River Regional Park	**Priority 1** S.63 Kent Street Weir Priority 3 S.64 Masons Landing Park	**Priority 1** V.31 Canning River Regional Park (Bush Forever site)
	19. Nicholson Road Bridge to Fancote Park (Canning River) and Margaret Street (Southern River)	**Priority 1** S.67 Bickley Brook to scarp on Southern and Canning rivers Priority 2 S.66 Djarlgarra Bridge (Roe Hwy) to O'Dell Street Priority 3 S.65 Hester Park S.68 Ferres Drive Bridge	**Priority 1** V.33 Canning and Southern rivers (Bush Forever site)
	20. Fancote Park to Stinton Creek	**Priority 1** S.67 Bickley Brook to scarp on Southern and Canning rivers (upper reaches)	**Priority 2** V.35 Collins Road, Roleystone Priority 3 V.38 Croyden Road, Roleystone
	21. Margaret Street (Southern River) to Allen Road Crossing	**Priority 1** S.67 Bickley Brook to scarp on Southern and Canning rivers (upper reaches)	**Priority 2** V.32 Dallen Road Bushland, Southern River, Gosnells (Bush Forever site)

5 References

Beard, J.S. 1973. The physiognomic approach. In *Handbook of Vegetation Science: Ordination and Classification of Communities,* ed R.H. Whittaker, 355 - 386. The Hague, Netherlands: Dr W. Junk b.v.

Biedenharn, D., Elliot, C. and Watson, C. 1997. *The WES Stream Investigation and Streambank Stabilisation Handbook*.

Chambers, J.M. 1987. The importance of fringing vegetation to the Swan-Canning estuary. In *The Swan River Estuary: Ecology and Management*, ed. J.John, 213 - 220. Report No. 1. Bentley: Curtin University Environmental Studies Group.

Damara. 2007. *Swan River Lower Estuary: Foreshore Condition Assessment*. Prepared for the Swan River Trust by Damara WA Pty Ltd, Report No. 04-001-01a.

Department of Conservation and Land Management. 1998. Swan Estuary Marine Park and Adjacent Nature Reserves Management Plan. Perth.

Eliot, I. and Eliot, M. 2003. *The Western Foreshore of the City of South Perth: Erosion Study*. A Report for the City of South Perth.

Deeley, D.M. and E.I. Paling. 1999. *Assessing the Ecological Health of Estuaries in Australia*. LWRRDC Occasional Paper 17/99. Perth: Institute for Environmental Science, Murdoch University.

Ecoscape. 1995. *Belmont Foreshore Environmental Management Plan: Goodwood Parade to the Sandringham Hotel*. Prepared for City of Belmont. Fremantle: Ecoscape (Australia) Pty. Ltd.

Ecoscape. 1999. *Environmental Management / Rehabilitation Plan, Swan River Foreshore: Concept Development Plan, Garvey Park.* Prepared for City of Belmont. Fremantle: Ecoscape (Australia) Pty Ltd.

Ecoscape. 2000. *Maylands Peninsula and Banks Reserve to Bardon Park Regional Recreation Paths: Environmental Assessment and Management Plan. Draft*. Prepared for Clifford Consulting. Freo: Ecoscape (Australia) Pty Ltd.

Hodgkin, E.P. 1987. The hydrology of the Swan River estuary: salinity the ecological master factor. In *The Swan River Estuary: Ecology and Management*, ed. J.John, 34 - 44. Report No. 1. Bentley: Curtin University Environmental Studies Group.

Oceanica, Damara and JDA, 2007. *Physical Foreshore Assessment of the Swan-Canning River System: Summary Report*. Report prepared for the Swan River Trust by Oceanica Consulting Pty Ltd in conjunction with Damara WA Pty Ltd and JDA Consultant Hydrologists, Report No. 592/2, Perth, Western Australia, June 2007.

Pen, L.J. 1983. *Peripheral Vegetation of the Swan and Canning Estuaries 1981*. Bulletin 113. Perth: Department of Conservation and Environment and Swan River Management Authority.

Pen, L.J. 1987. Peripheral vegetation of the Swan-Canning estuary – past, present and future. In *The Swan River Estuary: Ecology and Management*, ed, J.John, 221 - 231. Report No. 1. Curtin University Environmental Studies Group, Bentley.

Pen, L.J. 1999. *Managing Our Rivers: A Guide to the Nature and Management of the Streams of South-west Western Australia*. East Perth: Water and Rivers Commission.

Rutherfurd, I.D., A. Ladson, J.T. Tilleard, M. Stewardson, S. Ewing, G. Brierley and K. Fryirs. 1998. Research and development needs for river restoration in Australia. Report to the Land and Water Resources Research and Development Corporation, Canberra.

Schafer, D., Roland, R. and Douglas, S. 2003. *Preliminary Evaluation of Critical Wave Energy Thresholds at Natural and Created Coastal Wetlands*, ERDC TN-WRP-HS-CP-2.2.

Seddon, G. 2004. *Sense of Place: A Response to an Environment. The Swan Coastal Plain, Western Australia*. Melbourne: Bloomings Books.

Specht, R.L. 1970. Vegetation. In *The Australian Environment*, ed. G.W. Leeper, 44-67. Melbourne: CSIRO and Melbourne University Press.

Specht, R.L., E.M. Roe and V.H. Boughton. 1974. Conservation of Major Plant Communities in Australia and Papua New Guinea. *Australian Journal of Botany Suppl*. 7: 667

Storey, A. W., Davies, P. M. and Creagh, S. 2002. *Preliminary Ecological Water Requirements for the Canning River System*, Report prepared for the Water and Rivers Commission by Aquatic Research Laboratory, University of Western Australia, Perth, WA, January 2002.

Swan Catchment Council. 2004. *The Swan Region Strategy for Natural Resource Management*. Midland: Swan Catchment Council.

Swan River Trust. 1997. Swan River System: Landscape Description. Report No. 28. Perth

Swan River Trust and City of South Perth. 2001. Sir James Mitchell Park Foreshore Management Plan. Swan River Trust Report No. 32

Technical Advisory Panel. 2007. *Potential Impacts of Climate Change on the Swan and Canning Rivers*. Technical Report to the Swan River Trust.

Thurlow, B.H., Chambers, J. and Klemm, V.V. 1986. *Swan-Canning Estuarine System: Environment, Use and the Future*. Report No. 9. Perth: Waterways Commission.

Water and Rivers Commission. 2000a. *Identifying the Riparian Zone*. Water Note 11. East Perth.

Water and Rivers Commission. 2000b. The Values of the Riparian Zone. Water Note 12. East Perth.

WAPC, 2003. *Statement of Planning Policy 2.6: State Coastal Planning Policy*, Prepared under section 5AA of the Town Planning and Development Act 1928, Western Australian Planning Commission.

6 Appendices

Appendix 1 Spatial coverage of Local Government Authorities

Table 1A Local Government Authorities location relative to the SRT Development Control area and the zones designated in this strategy

Zone	Local Government Authority	Area of foreshore in Trust Development Control Area (ha)	% of Development Control Area assessed
Estuary	Town of Claremont	6.4	100
Estuary	Town of East Fremantle	15.5	100
Estuary	City of Fremantle	14.0	100
Estuary	City of Melville	107.0	100
Estuary	Town of Mosman Park	32.4	100
Estuary	City of Nedlands	36.9	100
Estuary	Shire of Peppermint Grove	5.6	100
Estuary	City of Perth	44.2	100
Estuary	City of South Perth	77.6	100
Estuary	City of Subiaco	19.7	100
Estuary	Town of Victoria Park	17.9	100
	Total Estuary	**377.1**	
Swan	Town of Bassendean	74.9	100
Swan	City of Bayswater	157.3	100
Swan	City of Belmont	125.8	100
Swan	Shire of Kalamunda	15.0	100
Swan	Shire of Mundaring	63.6	100
Swan	City of Perth	29.0	100
Swan	City of Swan	886.7	99.9
Swan	Town of Victoria Park	47.4	100
Swan	Town of Vincent	6.8	100
	Total Swan	**1406.6**	
Canning	City of Armadale	99.8	100
Canning	City of Canning	279.6	94
Canning	City of Gosnells	420.0	100
Canning	City of Melville	7.1	100
Canning	City of South Perth	39.2	100
	Total Canning	**845.7**	

Table 1B Local Government Authorities linear coverage of the shoreline

Zone	Local Government Authority	Shoreline length (km)	Coverage within zone (%)	Percentage assessed (%) in physical component
Estuary	Town of Claremont	1.9	3	100
Estuary	Town of East Fremantle	3.5	5.5	100
Estuary	City of Fremantle	2.9	5	100
Estuary	City of Melville	18.3	29	100
Estuary	Town of Mosman Park	4.7	7	100
Estuary	City of Nedlands	4.9	8	100
Estuary	Shire of Peppermint Grove	1.6	2.5	100
Estuary	City of Perth	9.2	15	100
Estuary	City of South Perth	12.3	19.5	100
Estuary	City of Subiaco	3	5	100
Estuary	Town of Victoria Park	0.9	1	100
	Total Estuary	**63.2**		
Swan	Town of Bassendean	5.4	3	100
Swan	City of Bayswater	9.7	5	100
Swan	City of Belmont	10.3	6	100
Swan	Shire of Kalamunda	3.8	2	0
Swan	Shire of Mundaring	17	9	0
Swan	City of Perth	3.4	2	100
Swan	City of Swan	125.4	69	83
Swan	Town of Victoria Park	5.4	3	100
Swan	Town of Vincent	0.9	0.5	100
	Total Swan	**181.3**		
Canning	City of Armadale	32.7	30%	17%
Canning	City of Canning	21.0	19%	100%
Canning	City of Gosnells	48.5	44%	68%
Canning	City of Melville	1.3	1%	100%
Canning	City of South Perth	5.6	5%	100%
	Total Canning	**109.1**		

Appendix 2 List of invasive species

Below is the complete list of invasive plant species for which data was specifically recorded. Species are listed in priority groupings.

Table 2A List of invasive species recorded in more detail

Structural layer	Species Name	Common Name	Department of Agriculture listing	Environmental Weed Strategy (WA) risk rating	Weed of National Significance	Mgt Priority Rating
Creepers	*Asparagus asparagoides*	Bridal creeper	Prohibited	High	Yes	5
Shrub	*Chrysanthemoides monilifera*	Boneseed	Prohibited, Declared	Moderate	Yes	5
Shrub	*Lantana camara*	Lantana	Prohibited, Declared	Moderate	Yes	5
Herb	*Salvinia molesta*	Salvinia	Prohibited	High	Yes	5
Tree	*Tamarix aphylla*	Athel pine / Tamarisk	Prohibited, Declared	Moderate	Yes	5
Grass	*Cortaderia selloana*	Pampas grass	Prohibited	High	No	4
Herb	*Eichhornia crassipes*	Water hyacinth	Declared	High	No	4
Herb	*Euphorbia terracina*	Geraldton carnation weed	Prohibited	High	No	4
Shrub	*Lycium ferocissimum*	African boxthorn	Prohibited	High	No	4
Herbs	*Moraea flaccida*	One leaf cape tulip	Declared	High	No	4
Shrub	*Rubus spp*	Blackberry	Declared	Moderate	Yes	4
Herb	*Typha orientalis*	Typha	Prohibited	High	No	4
Herbs	*Watsonia meriana*	Bulbil watsonia	Prohibited	High	No	4
Herbs	*Zantedeschia aethiopica*	Arum lily	Declared	High	No	4
Herb	*Brassica tournefortii*	Wild / Mediterranean turnip	Not registered	High	No	3
Grass	*Bromus diandrus*	Great brome	Not registered	High	No	3
Grass	*Cenchrus ciliaris*	Buffel grass	Not registered	High	No	3
Grass	*Ehrharta calycina*	Perennial veldt grass	Not registered	High	No	3
Grass	*Eragrostis curvula*	African love grass	Not registered	High	No	3
Herbs	*Freesia alba x leichtlinii*	Freesia	Not registered	High	No	3
Shrub	*Gomphocarpus fruticosus*	Swan plant or Narrowleaf cottonbush	Declared	Moderate	No	3
Grass	*Hyparrhenis hirta*	Tambookie grass	Not registered	High	No	3
Herbs	*Lachenalia reflexa*	Yellow soldiers	Not registered	High	No	3
Grass	*Lagurus ovatus*	Hare's tail grass	Not registered	high	No	3
Tree	*Leptospermum laevigatum*	Victorian tea tree	Not registered	high	No	3

Structural layer	Species Name	Common Name	Department of Agriculture listing	Environmental Weed Strategy (WA) risk rating	Weed of National Significance	Mgt Priority Rating
Herb	*Lupinus cosentinii*	Blue lupin	Not registered	High	No	3
Herb	*Malva dendromorpha*	Tree mallow	Not registered	High	No	3
Herb	*Myriophyllum aquaticum*	Parrot's feather, Brazilian water milfoil	Declared	Moderate	No	3
Herb	*Pelargonium capitatum*	Rose pelargonium	Not registered	High	No	3
Herbs	*Romulea rosea*	Guildford grass	Not registered	High	No	3
Shrub	*Solanum linneaenum*	Apple of sodom	Declared	Moderate	No	3
Herbs	*Sparaxis bulbifera*	Harlequin flower	Not registered	High	No	3
Herb	*Alternanthera philoxeroides*	Alligator weed	Prohibited	Low	Yes	2
Herb	*Chondrilla juncea*	Skeleton weed	Prohibited, Declared	Low	No	2
Sedge	*Juncus acutus*	Spiny rush	Not registered	Moderate	No	2
Tree	*Olea europaea*	Olive	Not registered	Moderate	No	2
Tree	*Schinus terebinthifolius*	Japanese / Brazilian pepper	Not registered	Moderate	No	2
Herb	*Echium plantagineum*	Patersons Curse	Declared	TBA	No	1
Herb	*Hydrocotyle ranunculoides*	Hydrocotyle	Declared	TBA	No	1
Creeper	*Ipomoea indica*	Morning glory	Not registered	Mild	No	1
Herbs	*Oxalis pes-caprae*	Soursob	Prohibited	TBA	No	1
Herb	*Sagittaria platyphylla*	Sagittaria	Declared	Low	No	1
Creeper	*Anredera cordifolia*	Madeira vine	Not registered	Low	No	0
Grass	*Arundo donax*	Giant reed	Not registered	Low	No	0
Creeper	*Cardiospermum grandiflorum*	Large balloon creeper	Not registered	Low	No	0
Herbs	*Colocasia esculenta*	Taro	Not registered	N/A	No	0
Herbs	*Ferraria crispa*	Black flag	Not registered	TBA	No	0
	Lonicera japonica	Japanese honeysuckle	Not registered	Low	No	0
Grass	*Pennisetum setaceum*	Fountain grass	Not registered	N/A	No	0
Shrub	*Ricinus communis*	Castor oil plant	Not registered	Low	No	0

Sources:
Department of Agriculture listing:
Declared and prohibited plants as stated under the *Agricultural and Related Resource Protection Act 1976.*

Environmental Weed Strategy (WA) (1999):
The Environmental Weed Strategy (WA) (1999) considered three criteria for assessment and ranking of weeds in terms of their environmental impact on biodiversity. Criteria for ranking and assessment were:

- invasiveness - ability to invade bushland in good to excellent condition or ability to invade waterways;
- distribution - wide current or potential distribution including consideration of known history elsewhere; and
- environmental impacts - ability to change structure, composition and function of ecosystems, particularly an ability to form a monoculture in a vegetation community.

The resulting risk ratings defined in the Weed Strategy were:

High - species scored yes for all three criteria.
Moderate - species scored yes for two of the above criteria.
Mild - species scored one of the above criteria.
Low - species scored none of the criteria.
TBA - species is listed in the strategy but has not been allocated a risk rating.

Note: A score of NA has been used where a species is not listed in the strategy.

Weeds of National Significance: A list of 20 weeds were selected nationally based on criteria relating to their invasiveness, impacts, potential for spread, and socio-economic and environmental values (Thorp and Lynch. 2000).

Management Priority Rating
A management priority rating was used assigned to each invasive species to enable a distinction of relative priority. The assigned rating is the sum of individual scores assigned for each of the three preceding criteria. Scores for each criterion are outlined below:

Department of Agriculture listing		Environmental Weed Strategy (WA) risk rating		Weeds of National Significance	
Status	**Score**	**Status**	**Score**	**Status**	**Score**
Prohibited	1	High	3	Recognized WoNS	1
Declared	1	Moderate	2		
		Mild	1		
		Low	0		
		TBA	0		

For example, a plant that is prohibited, has a high risk rating and is a WoNS would score 5 as its management priority score. Note, the higher the score, the greater the management priority.

Appendix 3 Degrading Influences

Vegetation units within the Swan Canning system were assessed for the following range of degrading influences:

- Dumped garden waste
- Dumped rubbish
- Dumped soil or rubble
- Disturbance around plant roots
- Broken vegetation
- Unearthed vegetation
- Trampled understorey
- Evidence of domestic animal grazing
- Evidence of fire
- Evidence of parking near vegetation
- Grass slashed in drain
- Mechanical tree removal
- Mowed grass beneath established trees
- Natural understorey mowed / slashed
- No delineation between lawn and vegetation
- Non-local indigenous species planted
- Path causing embankment / swale
- No delineation between garden and vegetation.

Appendix 4 Summarised sub-formations

Table 4A Vegetation formations as recorded under the attribute field Formation

Life-form of tallest stratum	% cover categories			
	71 – 100%	31 – 70%	11 – 30%	2 – 10%
Trees	Closed forest	Forest	Woodland	Open woodland
Shrubs >2 m	Closed scrub	Scrub	Tall shrubland	Tall open shrubland
Shrubs <2 m	Low closed heathland	Low heathland	Low shrubland	Low open shrubland
Shrubs mixed heights	Closed heathland	Heathland	Shrubland	Open shrubland
Sedges	Closed sedgeland	Sedgeland	Open sedgeland	Very open sedgeland
Grasses	Closed grassland	Grassland	Open grassland	Very open grassland
Herbs	Closed herbland	Herbland	Open herbland	Very open herbland
Mixed herbaceous	Closed herbaceous	Herbaceous	Open herbaceous	Very open herbaceous
Mixed woody herbaceous	Closed woody-herbaceous	Woody-herbaceous	Open woody-herbaceous	Very open woody-herbaceous

Note: Modified from Specht (1970), Specht *et al*. (1974); Beard (1973). Shading is used to illustrate the grouping of formations and the second table defines the sub-formation categories used).

Table 4B Summarised vegetation formations used for mapping purposes

Life-form of tallest stratum	% cover categories	
	31 – 100%	2 - 30%
Trees	Forest	Woodland
Shrubs	Thicket	Shrubland
Sedges	Sedgeland	
Grasses	Grassland	
Herbs Mixed herbaceous	Herbaceous	
Mixed woody-herbaceous	Woody-herbaceous	

Appendix 5 Sediment transport mechanisms in the estuary

Table 5A Relative importance of sediment transport mechanisms across the estuary

Location in the estuary	Relative importance of sediment transport mechanisms
Fremantle to Chidley Point	This section of river foreshore is intensively walled. Due to the potential for relatively dramatic bed level changes, high stress upon the walls will be anticipated requiring greater embedment than in other locations.
Chidley Point to Keanes Point	As the tidal gorge varies between acting as a sediment sink and a sediment source, the sandy foreshore within Mosman Bay is unstable. Foreshore works must be designed to cater for bed movements and it is likely that occasional renourishment will be required for Mosman Bay beach.
Keanes Point to Claremont Cliffs	Peppermint Grove beach is a natural zone of accumulation. However, accretion is limited by the size of Butler Hump and sediment supply from the Claremont Cliffs is very low. Consequently, this may be considered a stable beach. Its low topography determines that it is subject to occasional inundation. While the talus material along Claremont Cliffs is resistant to wave action, it is subject to gradual degradation and erosion. Foreshore structures, including Lover's Walk pathway, are likely to be affected by very gradual foreshore retreat.
Claremont Cliffs to Point Resolution	The small pocket beaches between Claremont and Point Resolution have limited sediment supply. Consequently, they may be expected to respond to seasonal patterns of accretion and erosion. The low topography of these beaches makes them subject to inundation.
Point Resolution to Nedlands Foreshore	The limit of foreshore walling at Iris Avenue is also a place of high stress due to river currents. The small beach west of Iris Avenue is expected to progressively erode, requiring further extension of the revetment structure.
Nedlands Foreshore to Pelican Point	A separation point in the direction of sediment transport suggests that erosion along Nedlands Foreshore is expected to be progressive. This has been enhanced through the provision of near-vertical walling, which causes wave reflection. Gradual accretion on the south side of Pelican Point may be expected to continue, affecting boat ramp use and stormwater drainage structures.
Pelican Point to UWA Boat Club	Changes in sediment transport direction cause foreshore movement on a seasonal or episodic basis, without causing progressive change. Management can be achieved through provision of an adequate setback, or structural defences that are only active during extreme conditions, such as a buried toe wall.
UWA Boat Club to Quarry Point	Bioengineered foreshore treatments in the vicinity of UWA Boat Shed are likely to be successful due to the generally accretive nature of this section of foreshore. However, some stresses may occur immediately west of the limestone walling during sustained easterly wind events.
Quarry Point to Narrows	This section of river foreshore is intensively walled, which spreads the progressive erosion expected near Quarry Point, causing a gradual deepening along an extended length. Near the Narrows, there is potential for dramatic bed level changes. Hence high stress upon the walls will be anticipated, requiring greater embedment than in other locations. This is further exacerbated by relatively high wave conditions. Seasonal removal of material at the Narrows to assist navigation may act to reduce the material available if the tidal flows relax, heightening the stress upon adjacent walls.
Narrows to Barrack Square	The beach east of the Narrows was apparently stable for an extended period of time after reclamation. However, it has since progressively eroded, which suggests long-term cycles of change, possibly associated with dynamics of the Narrows channel, including sand harvesting which is undertaken seasonally. The slow rate of erosion observed suggests that renourishment is an appropriate technique to manage erosion in this vicinity. A portion of sand harvested from the south side of the Narrows should be used here.

Barrack Square to Point Fraser	Foreshore responses due to sediment transport have been largely masked by the presence of walling, which acts to spread any zones of erosion or deposition. This area is relatively low level and is subject to seasonal overtopping and occasional inundation. Slow net erosion in the vicinity of Barrack Square reduces navigation concerns, but is likely to require consideration for the stability of foreshore works. Removing the walls would produce significant flattening of the profile, with corresponding loss of at least 30 m of foreshore. Absence of sediment supply along this section also restricts the effectiveness of pocket beaches.
Point Walter to Alfred Cove	The impervious nature of the Point Walter jetty exacerbates erosion problems on the foreshore immediately to the east. Other impermeable structures, particularly the two Point Walter boat ramps are subject to updrift accretion and downdrift erosion, which may reverse direction seasonally.
Alfred Cove to South Lucky Bay	The Alfred Cove lagoon is a potentially unstable bathymetric feature. It has the capacity to experience dramatic sedimentation over a relatively short period of time. The low topography of this area is susceptible to inundation.
South Lucky Bay to Point Dundas	The extended reach over which alongshore sediment transport occurs determines that the northern and southern parts of Lucky Bay foreshore are subject to episodic erosion. Foreshore structures in these areas must cater for large changes of bed level and will be subject to fluctuating downdrift erosion. Longer-term stability of the foreshore suggests that unobtrusive defensive measures may be effective.
Point Dundas to Applecross Jetty	The site is subject to episodic erosion, but has limited capacity for sediment to return. Consequently, erosion may be expected to be progressive. The small groynes are unlikely to be effective. While the mattresses offer a greater level of protection, their value may be compromised if erosion advances sufficiently. This site may be considered for occasional renourishment.
Applecross Jetty to Point Heathcote	Progressive erosion is expected to continue, for which effective management requires a renourishment program or closure of the eastern end of Waylen Bay.
Point Heathcote to Coffee Point	Sedimentation of the South of Perth Yacht Club is expected to occur on a gradual basis.
Coffee Point to Canning Bridge	Reclamation works undertaken for the South of Perth Yacht Club are likely to have had a detrimental effect upon Canning Beach foreshore. Progressive erosion is likely to result. Walling may be expected to experience increasing stress as the bed lowers.
Canning Bridge to Scout Hall	Gradual erosion towards the centre of this embayment is expected to continue. This will eventually require strengthening of the existing walling.
Scout Hall to Como	Ongoing erosion of Como Beach is to be expected. This is a direct threat to the Kwinana Freeway precinct and should be addressed as a high priority.
Como to Milyu	Gradual progressive erosion is expected to continue along this section of foreshore due to northwards sediment transport. There is presently sufficient setback from the freeway precinct to allow for gradual erosion for a number of years.
Milyu to Narrows	Provision of groynes along this section of foreshore prevents southerly sediment transport, which enhances the rate of erosion experienced on Como Beach and sediment accumulation at the Narrows.
Narrows to Mends Street	Potential movements of the tidal channel through the Narrows may provide dramatic movements of the bed levels along the foreshore. This has occurred historically, but has been relatively stable over recent years.
Mends Street to Ellam Street	Locally enhanced stresses occur where the bed is lowered adjacent to the foreshore walling. This may be caused by both river flows and wave action, particularly between Hurlingham Road and Ellam Street.

Appendix 6 Summary of Local Government Authority statistics for shorelines and structures

Table 6A Shore type for each LGA

	Built structure		Rocky		Sedimentary		Mixed vegetated / sedimentary		Vegetated		Variable (estuary)	
LGA	**km**	**% LGA**	**km**	**% LGA**	**km**	**% LGA**	**km**	**% LGA**	**km**	**% LGA**	**km**	**% LGA**
Claremont			0.4	21%	**1.5**	**79%**						
East Fremantle	**1.5**	**43%**	0.3	9%	1.1	31%					0.6	17%
Fremantle	**1.2**	**41%**	0.7	24%	**1.2**	**41%**						
Melville	2.5	14%	1.5	8%	**10.7**	**59%**	3.3	18%			0.4	2%
Mosman Park			0.8	17%	3.9	83%						
Nedlands	**2.4**	**49%**	0.6	12%	1.9	39%						
Peppermint Grove			**0.8**	**50%**	**0.8**	**50%**						
Perth	**8.1**	**88%**			0.8	9%	0.3	3%				
South Perth	**4.8**	**39%**			4.0	33%	2.1	17%			1.5	12%
Subiaco	0.4	13%			**2.6**	**87%**						
Victoria Park	**0.9**	**100%**										
Total Estuary	21.8	34%	5.1	8%	**28.5**	**45%**	5.7	9%			2.5	4%
Bassendean	**1.8**	**33%**			0.9	17%	1.2	21%	1.5	28%		
Bayswater	1.3	14%			1.7	18%	1.6	17%	**5.0**	**52%**		
Belmont	2.1	21%			1.0	10%	1.4	14%	**5.7**	**56%**		
Perth	**2.8**	**82%**			0.6	18%						
Swan	1.6	2%	**46.3**	**45%**	5.5	5%	16.9	16%	33.4	32%		
Victoria Park					1.3	25%	0.5	9%	**3.6**	**67%**		
Vincent	0.3	36%							**0.6**	**64%**		
Total Swan	10.0	7%	46.3	33%	11.1	8%	21.6	16%	**49.8**	**36%**		
Armadale							0.7	13%	**4.8**	**87%**		
Canning	0.7	3%			1.2	5%	1.2	6%	**17.9**	**85%**		
Gosnells	0.8	2%			0.5	1%	7.4	23%	**24.1**	**74%**		
Melville							0.4	30%	**0.9**	**70%**		
South Perth	0.1	1%	0.6	11%	0.2	4%	2.0	36%	**2.7**	**48%**		
Total Canning	1.6	2%	0.6	1%	1.8	3%	11.8	18%	**50.4**	**76%**		

Table 6B Lengths of shore sub-type for each LGA along the Swan foreshore (km)

Shore type	Sub-types	Bassendean	Bayswater	Belmont	Perth	Swan	Victoria Park	Vincent	Total Swan
Rocky	Rocky	-	-	-	-	**46.3**	-	-	46.3
Built	Built structure	**1.8**	1.3	2.1	**2.8**	1.6	-	0.3	10.0
Sedimentary	Beach	0.1	0.4	-	0.6	0.2	0.2	-	1.6
	Exposed bank	0.1	0.9	0.2	-	3.4	0.3	-	4.9
	Scarp	0.8	0.4	0.0	-	0.3	0.7	-	2.1
	Embankment	-	-	-	-	1.6	-	-	1.6
	Exposed bank and scarp			0.8	-	-	-	-	0.8
	Beach and scarp	-	-	-	-	-	-	-	

Shore type	Sub-types	Bassendean	Bayswater	Belmont	Perth	Swan	Victoria Park	Vincent	Total Swan
Mixed vegetated / sedimentary	Sedge and exposed bank	0.9	0.7	0.5	-	1.0	-	-	3.2
	Sedge and beach	-	-		-	-	0.5	-	0.5
	Tree-lined and exposed bank	0.2	-	0.9	-	13.1	-	-	14.3
	Tree-lined, exposed bank and sedge	-	-	-	-	0.2	-	-	0.2
	Grass / weeds. and exposed bank	-	-	-	-	0.8	-	-	0.8
	Sedge and scarp	-	-	-	-	0.3	-	-	0.3
	Beach and tree	-	0.9	-	-	-	-	-	0.9
	Beach, tree and sedge	-	-	-	-	-	-	-	
	Grass / weeds and exposed bank	-	-	-	-	0.8	-	-	0.8
	Grass / weeds, tree and exposed bank	-	-	-	-	0.7	-	-	0.7
Vegetated	Tree-lined	-	-	0.2	-	19.1	-	-	19.3
	Sedge	0.5	**4.4**	1.8	-	3.4	3.6	0.6	14.4
	Grass / weeds	-	-	-	-	0.4	-	-	0.4
	Tree-lined and sedge	1.0	0.5	**3.7**	-	5.5	-	-	10.7
	Tree-lined and grass / weeds	-	-	-	-	5.0	-	-	5.0
	Tree-lined, sedge and grass / weeds	-	-	-	-	-	-	-	

Table 6C Lengths of shore sub-type for each LGA along the Canning foreshore (km)

Shore type	Sub-types	Armadale	Canning	Gosnells	Melville	South Perth	Total Canning
Rocky	Rocky	-	-	-	-	0.6	0.6
Built	Built structure	-	0.7	0.8	-	0.1	1.6
Sedimentary	Beach	-	1.0	-	-	0.1	1.2
	Exposed bank	-	0.1	0.4	-	-	0.5
	Scarp	-	-	0.1	-	-	0.1
	Embankment	-	-	-	-	-	
	Exposed bank and scarp	-	-	-	-	-	
	Beach and scarp	-	-	-		0.2	0.2
Mixed vegetated / sedimentary	Sedge and exposed bank	-	-	0.8	-	-	0.8
	Sedge and beach	-	1.2	-	0.4	1.8	3.4
	Tree-lined and exposed bank	-	-	6.2	-	-	6.2
	Tree-lined, exposed bank and sedge	-	-	-	-	-	
	Grass / weeds. and exposed bank	-	-	-	-	-	
	Sedge and scarp	-	0.04	-	-	-	0.0
	Beach and tree	-	-	-	-	-	
	Beach, tree and sedge	-	-	-		0.2	0.2
	Grass / weeds and exposed bank	-	-	-	-	-	
	Grass / weeds, tree and exposed bank	0.7	-	0.4	-	-	1.2
Vegetated	Tree-lined	1.6	5.1	**11.4**	-	-	18.0
	Sedge	-	5.5	-	-	**2.6**	8.1
	Grass / weeds	-	-	2.1	-	-	2.1
	Tree-lined and sedge	-	**7.3**	0.5	**0.9**	0.2	8.8
	Tree-lined and grass / weeds	**3.3**	-	8.8	-	-	12.1
	Tree-lined, sedge and grass / weeds	-	-	1.4	-	-	1.4

Table 6D Mid-shore / bank erosion along the Swan and Canning foreshores

	<33%		33–67%		>67%	
LGA	**km**	**% LGA**	**km**	**% LGA**	**km**	**% LGA**
Bassendean	0.5	10%	2.3	41%	**2.6**	**49%**
Bayswater	1.9	20%	2.1	21%	**5.7**	**59%**
Belmont	1.3	13%	4.5	44%	**4.5**	**44%**
Perth	**1.5**	**44%**	1.0	30%	0.9	26%
Swan	37.0	36%	**41.5**	**40%**	25.2	24%
Victoria Park	1.4	26%	1.3	24%	2.7	**50%**
Vincent	-	-	**0.9**	**100%**	-	-
Total Swan	43.6	31%	53.5	39%	41.5	30%
Armadale	2.0	35%	**2.4**	**43%**	1.2	22%
Canning	**13.8**	**66%**	6.4	31%	0.8	4%
Gosnells	10.9	33%	**17.2**	**53%**	4.6	14%
Melville	**0.7**	**55%**	0.6	45%	-	-
South Perth	**3.5**	**62%**	1.1	20%	1.0	17%
Total Canning	30.9	47%	27.7	42%	7.6	11%

Table 6E Mid-shore / bank erosion for sedimentary shore types along the Swan and Canning foreshores

	<33%		33–67%		>67%	
LGA	**km**	**% LGA**	**km**	**% LGA**	**km**	**% LGA**
Bassendean	**-**	**-**	0.1	8%	**0.9**	**92%**
Bayswater	0.4	26%	**-**	**-**	**1.3**	**74%**
Belmont	**-**	**-**	0.8	79%	**0.2**	**21%**
Perth	**0.6**	**100%**	**-**	**-**	**-**	**-**
Swan	**3.7**	**67%**	0.1	2%	1.7	31%
Victoria Park	**-**	**-**	**-**	**-**	**1.3**	**100%**
Vincent	**-**	**-**	**-**	**-**	**-**	**-**
Swan sedimentary	4.7	43%	1.0	9%	5.4	48%
Armadale	**-**	**-**	**-**	**-**	**-**	**-**
Canning	**0.7**	**62%**	0.3	25%	0.1	12%
Gosnells	**-**	**-**	0.2	36%	**0.3**	**64%**
Melville	**-**	**-**	**-**	**-**	**-**	**-**
South Perth	**0.1**	**71%**	**-**	**-**	0.1	29%
Canning sedimentary	0.9	47%	0.5	25%	0.5	28%

Table 6F Upper-shore / floodplain scarping along the Swan and Canning foreshores

	<33%		33-67%		>67%		None	
LGA	**km**	**% LGA**	**km**	**% LGA**	**km**	**% LGA**	**km**	**% LGA**
Bassendean	0.5	10%	-	-	0.8	14%	**4.1**	**76%**
Bayswater	0.5	6%	-	-	0.9	10%	**8.2**	**85%**
Belmont	1.6	15%	0.6	6%	0.9	9%	**7.2**	**70%**
Perth	0.3	8%	**2.2**	**66%**	-	-	0.9	26%
Swan	20.8	20%	17.0	16%	2.0	2%	**63.9**	**62%**
Victoria Park	-	-	0.9	16%	-	-	**4.5**	**84%**
Vincent	0.6	64%	0.3	36%	-	-	-	-
Total Swan	24.3	18%	21.0	15%	4.6	3%	88.8	64%
Armadale	0.08	1%	-	-	-	-	**5.5**	**99%**
Canning	1.9	9%	0.3	1%	0.2	1%	**18.6**	**89%**
Gosnells	2.4	7%	1.9	6%	-	-	**28.5**	**87%**
Melville	-	-	**0.6**	**50%**	-	-	0.6	50%
South Perth	2.0	36%	0.2	4%	0.1	1%	**3.3**	**59%**
Total Canning	6.4	10%	3.0	5%	0.2	0%	56.5	85%

Table 6G Discharge types

LGA	Drains	Drainage channels	Tributaries	Total discharges
Claremont	1	Not recorded	Not recorded	1
East Fremantle	23	Not recorded	Not recorded	23
Fremantle	23	Not recorded	Not recorded	23
Melville	80	Not recorded	Not recorded	80
Mosman Park	11	Not recorded	Not recorded	11
Nedlands	6	Not recorded	Not recorded	6
Peppermint Grove	13	Not recorded	Not recorded	13
Perth	80	Not recorded	Not recorded	80
South Perth	62	Not recorded	Not recorded	62
Subiaco	8	Not recorded	Not recorded	8
Victoria Park	6	Not recorded	Not recorded	6
Total Estuary	313	N/A	N/A	313
Bassendean	7	2	0	9
Bayswater	25	8	0	33
Belmont	33	6	0	39
Perth	18	2	0	20
Swan	44	16	19	79
Victoria Park	9	1	0	10
Vincent	4	3	0	7
Total Swan	140	38	19	197
Armadale	18	7	4	29
Canning	51	6	0	57
Gosnells	45	16	6	67
Melville	9	0	0	9
South Perth	4	8	0	12
Total Canning	127	37	10	174

Table 6H Drainage impacts and design features for drains along the Swan and Canning foreshores

	Impacts				Design Features			
LGA	Scour	Bar	Ponding	Bank retreat	Headwall	Scour apron	Pollutant trap	Plinth
Bassendean	4	0	0	4	4	3	0	0
Bayswater	6	3	2	7	12	2	2	1
Belmont	10	3	2	10	16	7	1	0
Perth	3	0	0	6	10	1	2	0
Swan	31	0	3	21	18	10	1	3
Victoria Park	4	4	0	3	6	0	1	0
Vincent	2	1	0	3	3	1	0	0
Total Swan	60	11	7	54	69	24	7	4
Armadale	10	0	0	1	10	6	0	0
Canning	14	7	6	11	30	9	4	2
Gosnells	33	3	6	21	25	13	5	0
Melville	3	1	2	2	6	1	0	1
South Perth	1	2	3	1	2	0	2	0
Total Canning	61	13	17	36	73	29	11	3

Table 6I Drainage management and impacts summary for drains along the Swan and Canning foreshores

LGA	Drains / channels causing impacts		Drains with design features	
	Number	%	Number	%
Bassendean	8	89%	5	56%
Bayswater	18	55%	13	39%
Belmont	25	64%	21	54%
Perth	9	45%	11	55%
Swan	55	92%	24	40%
Victoria Park	11	100%	6	60%
Vincent	6	86%	3	43%
Total Swan	132	74%	83	47%
Armadale	11	44%	11	44%
Canning	38	67%	36	63%
Gosnells	63	100%	28	46%
Melville	8	89%	8	89%
South Perth	7	58%	3	25%
Total Canning	127	77%	86	52%

Table 6J Structure type

LGA	Length of structure type (km)					
	Revetment	Wall	Log Wall	Gabion	Other	Total
Claremont	**0.15**	0.08	-	-	-	0.23
East Fremantle	0.51	**1.48**	-	0.26	0.03	2.28
Fremantle	**1.14**	0.36	-	-	-	1.49
Melville	**1.80**	0.85	0.16	0.67	0.39	3.88
Mosman Park	0.37	**0.86**	-	-	0.01	1.23
Nedlands	0.02	**2.42**	-	-	-	2.43
Peppermint Grove	-	0.77	-	-	-	0.77
Perth	2.47	**2.83**	-	0.70	-	6.00
South Perth	0.98	**4.62**	0.03	0.15	-	5.78
Subiaco	-	**0.69**	-	-	-	0.69
Victoria Park	0.26	**0.55**	-	-	-	0.81
Total Estuary	7.69	**15.49**	0.20	1.79	0.43	25.60
Percentage Estuary (%)	30%	**61%**	1%	7%	2%	
Bassendean	**0.31**	0.11	-	-	0.04	0.46
Bayswater	0.24	0.20	**0.41**	-	0.04	0.88
Belmont	0.40	0.34	**0.61**	0.18	0.11	1.64
Perth	**1.17**	0.15	-	-	0.49	1.81
Swan	**0.41**	0.28	0.27	-	0.11	1.07
Victoria Park	**0.55**	0.16	-	-	-	0.71
Vincent	**0.18**	-	-	-	-	0.18
Total Swan	**3.26**	1.24	1.29	0.18	0.78	6.75
Percentage Swan (%)	**48%**	18%	19%	3%	12%	
Armadale	-	-	-	-	-	-
Canning	-	0.19	-	**0.33**	0.02	0.59
Gosnells	**0.26**	0.17	0.03	-	0.03	0.50
Melville	-	-	-	-	-	-
South Perth	**0.05**	-	-	-	-	-
Total Canning	0.31	**0.36**	0.03	0.33	0.05	1.14
Percentage Canning (%)	27%	**32%**	3%	29%	4%	

Table 6K Structure condition

	Good		Fair		Poor	
LGA	**km**	**% LGA**	**km**	**% LGA**	**km**	**% LGA**
Claremont	0.08	34%	0.05	22%	**0.10**	**44%**
East Fremantle	0.92	40%	**0.98**	**43%**	0.39	17%
Fremantle	0.36	24%	0.51	34%	**0.62**	**41%**
Melville	-	-	**3.19**	**82%**	0.54	14%
Mosman Park	0.17	13%	**0.69**	**56%**	0.37	30%
Nedlands	-	-	**1.85**	**76%**	0.59	24%
Peppermint Grove	-	-	**0.46**	**61%**	0.30	39%
Perth	1.26	21%	1.42	24%	**3.32**	**55%**
South Perth	1.48	26%	**3.80**	**66%**	0.49	9%
Subiaco	0.17	24%	**0.49**	**71%**	0.03	5%
Victoria Park	0.14	17%	**0.67**	**83%**		
Total Estuary	4.57	18%	14.12	55%	6.76	26%
Bassendean	**0.43**	**93%**	0.03	7%	-	-
Bayswater	0.16	18%	0.18	20%	**0.54**	**61%**
Belmont	0.50	31%	0.56	34%	**0.58**	**35%**
Perth	0.27	15%	**1.55**	**85%**	-	-
Swan	0.20	19%	0.23	21%	**0.64**	**60%**
Victoria Park	0.14	20%	0.13	19%	**0.44**	**62%**
Vincent	**0.14**	**76%**	0.04	24%	-	-
Total Swan	1.84	27%	2.72	40%	2.19	32%
Armadale	-	-	-	-	-	-
Canning	0.08	14%	**0.31**	**53%**	0.19	33%
Gosnells	**0.34**	**68%**	0.13	26%	0.03	5%
Melville	-	-	-	-	-	-
South Perth	**0.05**	**100%**	-	-	-	-
Total Canning	0.48	42%	0.44	39%	0.22	19%

Table 6L Structure function

	Good		Fair		Poor		Non-retaining	
LGA	**km**	**% LGA**	**km**	**% LGA**	**km**	**% LGA**	**km**	**% LGA**
Claremont	0.08	34%	**0.15**	**66%**	-	-	-	-
East Fremantle	**2.10**	**92%**	0.18	8%	-	-	-	-
Fremantle	**0.77**	**52%**	0.71	48%	0.01	1%	-	-
Melville	**2.96**	**76%**	0.52	13%	0.39	10%	-	-
Mosman Park	**0.52**	**42%**	0.36	29%	0.36	29%	-	-
Nedlands	-	-	**2.43**	**100%**	-	-	-	-
Peppermint Grove	**0.46**	**61%**	0.30	39%	-	-	-	-
Perth	1.72	29%	**2.61**	**43%**	1.68	28%	-	-
South Perth	**2.88**	**50%**	2.58	45%	0.32	6%	-	-
Subiaco	**0.59**	**86%**	0.10	14%	-	-	-	-
Victoria Park	0.14	17%	**0.67**	**83%**	-	-	-	-
Total Estuary	12.22	48%	10.61	41%	2.76	11%		
Bassendean	**0.43**	**93%**	-	-	0.03	7%	-	-
Bayswater	0.13	14%	0.28	32%	**0.44**	**50%**	0.04	4%
Belmont	0.35	21%	0.45	27%	**0.84**	**51%**	-	-
Perth	0.76	42%	**0.83**	**46%**	0.23	13%	-	-
Swan	0.23	21%	0.22	20%	**0.59**	**55%**	0.04	4%
Victoria Park	0.07	10%	0.11	16%	**0.53**	**74%**	-	-
Vincent	0.05	28%	**0.13**	**72%**	-	-	-	-
Total Swan	2.01	30%	2.01	30%	2.65	40%	0.08	1%
Armadale	-	-	-	-	-	-	-	-
Canning	0.25	51%	**0.29**	**58%**	0.05	10%	-	-
Gosnells	**0.33**	**67%**	0.16	33%	-	-	-	-
Melville	-	-	-	-	-	-	-	-
South Perth	**0.05**	**100%**	-	-	-	-	-	-
Total Canning	0.64	56%	0.45	40%	0.05	4%	-	-

Foreshore stability problems

Table 6M Recommended works for structures

	No urgent works required		Immediate maintenance		Rebuild		Rebuild or remove		Potential revegetation	
LGA	**km**	**% LGA**	**km**	**% LGA**	**km**	**% LGA**	**km**	**% LGA**	**km**	**% LGA**
Bassendean	**0.39**	**85%**	0.07	15%	-	-	-	-	-	-
Bayswater	0.04	4%	0.26	29%	0.25	28%	0.24	28%	0.09	11%
Belmont	0.17	10%	**0.96**	**59%**	0.23	14%	0.22	13%	0.06	3%
Perth	0.19	10%	**1.62**	**90%**	-	-	-	-	-	-
Swan	0.13	12%	0.23	22%	0.12	11%	0.06	5%	**0.54**	**50%**
Victoria Park	0.18	26%	0.09	13%	-	-	**0.44**	**62%**	-	-
Vincent	0.04	24%	**0.14**	**76%**	-	-	-	-	-	-
Total Swan	1.14	17%	3.37	50%	0.60	9%	0.95	14%	0.69	10%
Armadale	-	-	-	-	-	-	-	-	-	-
Canning	0.12	20%	**0.28**	**47%**	0.12	21%	-	-	0.07	12%
Gosnells	**0.30**	**60%**	0.17	35%	-	-	-	-	0.03	5%
Melville	-	-	-	-	-	-	-	-	-	-
South Perth	**0.05**	**100%**	-	-	-	-	-	-	-	-
Total Canning	0.47	41%	0.45	40%	0.12	11%	-	-	0.10	9%

Table 6N Potential causes of inadequate natural stability along the Swan and Canning foreshores

	Animal trampling		Uncontrolled access		Boat launching / landing		Bicycle tracks / jumps		Worm digging		One of these causes of inadequate natural stability	
LGA	**km**	**% LGA**	**km**	**% LGA**	**km**	**% LGA**	**km**	**% LGA**	**km**	**% LGA**	**km**	**% LGA**
Bassendean	-	-	2.4	44%	-	-	-	-	1.5	27%	2.4	44%
Bayswater	-	-	3.9	41%	0.8	8%	-	-	-	-	4.5	46%
Belmont	-	-	4.8	47%	0.8	8%	-	-	-	-	4.8	47%
Perth	-	-	2.9	87%	0.6	18%	-	-	-	-	2.9	87%
Swan	37.0	36%	48.3	47%	2.4	2%	-	-	1.8	2%	59.2	57%
Victoria Park	-	-	2.8	51%	-	-	-	-	-	-	2.8	51%
Vincent	-	-	0.9	100%	-	-	-	-	-	-	0.9	100%
Total Swan	37.0	27%	66.1	48%	4.6	3%	-	-	3.2	2%	77.6	56%
Armadale	1.4	25%	1.9	34%	-	-	-	-	-	-	1.9	34%
Canning	0.1	1%	11.1	53%	2.0	10%	-	-	-	-	11.5	55%
Gosnells	1.9	6%	10.6	32%	-	-	3.1	9%	-	-	12.9	39%
Melville	-	-	1.0	75%	0.6	50%	-	-	-	-	1.0	75%
South Perth	-	-	1.1	19%	0.1	3%	-	-	-	-	1.2	22%
Total Canning	3.5	5%	25.7	39%	2.8	4%	3.1	5%	-	-	28.5	43%

Table 6O Potential inadequate natural stability along the Swan and Canning foreshores – variable sediment strata

	Variable sediment strata	
LGA	**km**	**% LGA**
Bassendean	2.2	41%
Bayswater	4.5	46%
Belmont	2.5	24%
Perth	0.7	22%
Swan	8.7	8%
Victoria Park	1.7	31%
Vincent	0.9	100%
Total Swan	21.2	15%
Armadale	-	-
Canning	0.4	2%
Gosnells	-	-
Melville	-	-
South Perth	0.2	4%
Total Canning	0.6	1%

Table 6P Disturbance of sediment transport patterns

	Sedimentation (In-Channel Deposits)		Drainage off Slope	
LGA	**km**	**% LGA**	**km**	**% LGA**
Bassendean	-	-	2.1	39%
Bayswater	0.6	6%	5.1	53%
Belmont	-	-	4.9	48%
Perth	-	-	-	-
Swan	64.2	62%	17.4	17%
Victoria Park	-	-	4.4	82%
Vincent	-	-	0.6	64%
Total Swan	64.8	47%	34.6	25%
Armadale	5.6	100%	1.7	31%
Canning	2.6	12%	2.6	12%
Gosnells	24.2	74%	9.7	30%
Melville	-	-	-	-
South Perth	-	-	-	-
Total Canning	32.3	49%	14.1	21%

Table 6Q Potential inadequate natural stability–width of tree / vegetation coverage

	Insufficient Width of Trees									
	Exposed roots		Exposed roots and no trees on floodplain / upper–shore		Exposed roots and bank vegetation cover <31%		Exposed roots and bank vegetation cover <71%		Revegetate or increase vegetation width	
LGA	km	% LGA	km	% LGA	km	% LGA	km	% LGA	km	% LGA
Bassendean	5.2	96%	0.8	14%	2.7	49%	5.1	93%	2.8	51%
Bayswater	5.6	58%	1.8	18%	3.3	34%	5.6	58%	8.4	87%
Belmont	8.1	79%	2.0	20%	1.1	10%	6.2	60%	7.0	69%
Perth	0.3	8%	-	-	0.3	8%	0.3	8%	2.4	70%
Swan	60.7	59%	8.6	8%	6.5	6%	50.2	48%	28.4	27%
Victoria Park	3.4	62%	0.3	6%	1.1	20%	2.0	37%	5.4	100%
Vincent	-	-	-	-	-	-	-	-	0.6	64%
Total Swan	83.3	60%	13.5	10%	15.0	11%	69.4	50%	54.9	40%
Armadale	5.6	100%	0.0	0%	-	-	1.6	29%	1.4	25%
Canning	11.7	56%	1.1	5%	-	-	2.9	14%	8.5	41%
Gosnells	28.9	88%	-	-	0.8	2%	14.0	43%	5.8	18%
Melville	1.0	75%	1.0	75%	1.0	75%	1.0	75%	1.0	80%
South Perth	1.4	25%	0.0	0%	0.0	0%	0.6	10%	0.7	12%
Total Canning	48.5	73%	2.1	3%	1.8	3%	20.0	30%	17.4	26%

Appendix 7 Recommended works for foreshore protection structures

Table 7A Recommended works for foreshore protection structures along the Estuary Foreshore

No.	Structure	Class	Retention	Recommended Works
1	Fremantle traffic bridge	Wall	Moderate	Upgrade
2	Point Direction Revetment 1	Revetment	Good	
3	Point Direction Revetment 2	Revetment	Good	
4	Point Direction Revetment 3	Revetment	Good	
5	Point Direction Walling 1	Wall	Good	
6	Point Direction Walling 2	Wall	Good	Maintain or repair
7	Point Direction Revetment 4	Revetment	Good	
8	Point Direction Revetment 5	Revetment	Moderate	Maintain
9	Water Police Walling	Wall	Good	Maintain or repair
10	Minim Cove Revetment 1	Revetment	Good	Review
11	Minim Cove Revetment 2	Revetment	Moderate	Review
12	Minim Cove Scarp Protection	Revetment	Poor	Review
13	Ferry Terminal Revetment	Revetment	Moderate	Repair
14	Northbank	Wall	Good	
15	Minim Cove Scarp Protection	Revetment	Poor	Review
16	Chidley Point Walling	Wall	Moderate	
17	Green Place Walling	Wall	Moderate	Maintain or repair
18	Mosman Park 1 Revetment	Revetment	Good	
19	Mosman Park 1 Low Walling	Wall	Good	
20	Mosman Park 1 Ramp	Ramp	Good	
21	Mosman Park 1 High Walling	Wall	Moderate	Maintain
22	Mosman Park 2 Groyne	Groyne	Moderate	Review
23	Mosman Park 2 Wall	Wall	Moderate	Maintain
24	Mosman Park 3 Wall	Wall	Good	Maintain
25	The Coombe Groyne	Groyne	Poor	Review
26	The Coombe Wall	Wall	Poor	Repair
27	The Coombe Revetment	Revetment	Poor	Repair
28	The Coombe Drain	Armoured	Poor	Review
29	Mosman Park 4 Wall	Wall	Good	Maintain
30	Mosman Jetty Revetment	Revetment	Moderate	Maintain
31	Oyster Beds Walling	Wall	Moderate	Maintain
32	Mosman Bay Walling	Wall	Good	Maintain
33	Freshwater Bay Walling 1	Wall	Good	Maintain
34	Freshwater Bay Walling 2	Wall	Good	
35	Freshwater Bay Walling 3	Wall	Moderate	Repair or replace
36	Christchurch Boatshed Revetment 1	Revetment	Moderate	Repair or replace
37	Christchurch Boatshed Revetment 2	Revetment	Moderate	Repair
38	RFBYC Retaining Wall	Wall	Moderate	Repair
39	Claremont Baths Revetment	Revetment	Good	
40	Victoria Avenue Resident's Walls	Wall	Moderate	Repair or replace
41	Sunset Hospital Revetment	Revetment	Moderate	Repair or replace
42	Sunset Hospital Walling	Wall	Moderate	Repair or replace
43	Nedlands Foreshore (S) Walling	Wall	Moderate	Repair or replace
44	Nedlands Foreshore (N) Walling	Wall	Moderate	Repair or replace
45	Tawarri W	Wall	Moderate	Review or replace
46	Nedlands Foreshore (N) Walling	Wall	Moderate	Repair or replace
47	Catalina Bay Walling	Wall	Good	Maintain
48	Pelican Point Carpark Wall 1	Wall	Moderate	Maintain
49	Pelican Point Carpark Wall 1	Wall	Moderate	Repair or replace
50	Matilda Bay Cafe	Wall	Good	Maintain

No.	Structure	Class	Retention	Recommended Works
51	Matilda Bay Bioengineering	Revetment	Good	
52	Matilda Bay Revetment	Revetment	Good	
53	Mounts Bay Road Walls	Wall	Moderate	Repair or replace
54	Mounts Bay Road Gabion Walls	Wall	Poor	Replace
55	Mounts Bay Road Gabion Walls	Wall	Poor	Replace
56	Swan Brewery (N) Revetment	Revetment	Moderate	Maintain or repair
57	Narrows Gabion Revetment	Revetment	Moderate	Replace
58	Narrows Gabion Walls	Wall	Poor	Repair or replace
59	Sloped Gabion Walling	Wall	Good	Maintain or repair
60	Sheet piling	Wall	Good	Maintain
61	Upper Level Gabions	Wall	Good	
62	Sloped Gabion Walling	Wall	Poor	Upgrade
63	Barrack Square Revetment	Revetment	Good	
64	Barrack Square Sheet piling	Wall	Good	
65	Barrack Square Concrete Revetment	Revetment	Moderate	Maintain
66	Esplanade (W) Concrete Revetment	Revetment	Moderate	Replace
67	Esplanade (E) Concrete Revetment 1	Revetment	Moderate	Replace
68	Esplanade (E) Concrete Revetment 2	Revetment	Poor	Replace
69	Ferry Terminal Revetment	Revetment	Moderate	Repair
70	Tradewinds Foreshore Walling	Wall	Good	Repair
71	Left Bank Foreshore Wall	Wall	Good	
72	Red Herring Revetment	Revetment	Moderate	Repair or replace
73	Red Herring Wall	Wall	Good	
74	Riverside Road Wall 1	Wall	Good	Maintain
75	Riverside Road Wall 2	Wall	Good	
76	Riverside Road Revetment 1*	Revetment	Good	
77	Marine Education Boatshed Sheet piling	Wall	Good	Repair or replace
78	Riverside Road Wall 3	Wall	Good	Maintain
79	Preston Point Foreshore Protection	Gabion Revetment	Good	
80	Swan Yacht Club Groyne	Groyne	Moderate	Maintain
81	Swan Yacht Club Wall 1	Wall	Good	
82	Swan Yacht Club Wall 2	Wall	Good	
83	RSL (?) Club Gabion Wall	Gabion Wall	Moderate	Repair or replace
84	Rec Hall Stairs	Stairs	Moderate	
85	Rec Hall Revetment	Revetment	Good	
86	Aquarama Revetment	Revetment	Good	
87	Aquarama Groyne	Groyne	Moderate	
88	Aquarama Walling	Wall	Good	
89	Riverside Road Revetment 2	Revetment	Good	
90	East Fremantle Sea Scouts	Wall	Good	Maintain
91	EFYC Retaining Wall (E)	Wall	Moderate	Maintain
92	Leeuwin Carpark	Revetment	Good	
93	EFYC Retaining Wall (E)	Wall	Moderate	Maintain
94	Bicton Baths Access Ramp	Ramp	Moderate	Maintain
95	Bicton Baths Revetment	Revetment	Good	
96	Bicton Baths Retaining Wall (S)	Wall	Good	Repair
97	Bicton Baths Retaining Wall (N)	Wall	Moderate	
98	Lucky Bay Revetment	Revetment	Moderate	Maintain or repair
99	Dee Road / Melville Beach Road cnr	Gabion Wall	Good	Maintain
100	Dee Road / Melville Beach Road cnr	Revetment	Good	
101	Point Dundas Walling	Revetment	Good	Upgrade

No.	Structure	Class	Retention	Recommended Works
102	Point Dundas Gabion Protection	Gabion Revetment	Good	Maintain
103	Waylen Bay Groynes	Groyne	Moderate	Maintain
104	Canning Beach Revetment	Revetment	Good	
105	Canning Bridge Abutment	Wall	Good	Maintain
106	Raffles Hotel River Wall	Wall	Good	Upgrade
107	Rowing Club Log Walls	Wall	Moderate	Repair
108	Helm Street Gabion Wall	Gabion Wall	Good	
109	Esplanade Foreshore Baffles	Baffles	Poor	
110	Gunbower Street Revetment	Revetment	Good	
111	Mount Pleasant Coir Logs	Coir Logs	Moderate	
112	Mount Henry Bridge Abutment	Revetment	Good	Maintain
113	Blackwall Reach Parade 1	Wall	Moderate	Repair
114	Blackwall Reach Parade 2	Gabion Wall	Good	Maintain
115	Dee Road / Melville Beach Road cnr	Gabion Revetment	Good	Maintain
116	Jeff Joseph Reserve baffle boards	Baffles	Poor	Review
117	Cale Street - Saunders Street Walling	Wall	Good	Maintain
118	Saunders Street Drain	Armoured	Moderate	Remove or review
119	Saunders Street - Greenock Avenue Walling	Wall	Good	
120	Greenock Avenue - Alston Avenue Walling	Wall	Good	
121	Alston Avenue Drain	Armoured		Remove or review
122	Alston Avenue - Thelma Street Walling	Wall	Good	
123	Thelma Street Drain	Armoured		Remove or review
124	Thelma Street Drain	Armoured		Remove or review
125	Thelma Street Bridge Abutment	Wall	Good	
126	Thelma Street Drain	Armoured		Remove or review
127	Thelma Street Drain	Armoured		Remove or review
128	Thelma Street - Ednah Street Walling	Wall	Good	
129	Ednah Street Drain	Armoured		Remove or review
130	Ednah Street Timber Wall	Wall	Moderate	
131	Ednah Street Baffles	Baffles	Poor	Remove or review
132	Ednah Street - Preston Street Walling	Wall	Good	
133	Ednah Street Baffles	Baffles	Moderate	
134	Preston Street Drain	Armoured		
135	Preston Street - Eric Street Walling	Wall	Moderate	Remove or review
136	Preston Street Drain	Armoured		Remove or review
137	Preston Street Drain	Armoured		Remove or review
138	Eric Street Walling	Wall	Poor	Repair or replace
139	Eric Street Drain	Armoured		Remove or review
140	Comer Street Bridge Abutment	Wall	Good	
141	South Perth Boat Ramp Groyne	Groyne	Moderate	Maintain or repair
142	Charles Street Bridge Abutment	Wall	Good	
143	Hardy Street Groyne	Groyne	Moderate	Maintain or repair
144	Hardy Street Revetment	Revetment	Good	
145	Judd Street Groyne	Groyne	Moderate	Maintain or repair
146	Judd Street Walling	Wall	Good	
147	Mill Point Road Bridge Abutment	Wall	Moderate	Maintain or repair
148	Scott Street Groyne	Groyne	Moderate	Maintain or repair
149	Scott Street Revetment	Revetment	Good	Maintain or repair
150	Stirling Street Groyne	Groyne	Moderate	Maintain or repair

No.	Structure	Class	Retention	Recommended Works
151	Stirling Street Revetment	Revetment	Good	
152	Queen Street Groyne	Groyne	Moderate	Maintain or repair
153	The Narrows Revetment (E)	Gabion Revetment	Moderate	Repair or replace
154	The Narrows Revetment (W)	Revetment	Poor	Repair or replace
155	The Narrows Gabion Wall	Wall	Moderate	
156	Esplanade River Wall	Wall	Good	Maintain
157	James Mitchell Park Wall 1	Wall	Moderate	Maintain or repair
158	James Mitchell Park Wall 2	Wall	Moderate	Repair or replace
159	James Mitchell Park Wall 3	Wall	Good	Repair or replace
160	James Mitchell Park Log Wall	Log Wall	Moderate	
161	James Mitchell Park Wall 4	Wall	Moderate	Repair or replace
162	James Mitchell Park Wall 5	Wall	Moderate	Repair or replace
163	Swanview Terrace Wall	Wall	Moderate	Repair or replace
164	Canning Bridge to Henley Street	Revetment	Good	Maintain or repair
165	Henley Street to Cale St	Wall	Good	Maintain or repair
166	Paterson Street to Wooltana Street Walling	Wall	Moderate	Maintain
167	Wooltana Street to Canning Bridge Wall	Wall	Good	Maintain
168	Manning Timber Fences	Fence	Poor	
169	Manning Timber Baffles	Baffles	Poor	
170	Ellam Street Depot Walling	Wall	Good	
171	Ellam Street Depot Ramp	Ramp	Good	
172	Ellam Street Revetment	Revetment	Moderate	Repair or replace
173	Floating Jetty Groyne	Groyne	Good	Review
174	Causeway Block Wall	Wall	Moderate	Maintain or repair

Table 7B Recommended works for foreshore protection structures along the Swan Foreshore

No.	Structure	Class	Retention	Recommended Works
175	Heirisson Island Revetment 1	Revetment	Fair	Immediate maintenance
176	Heirisson Island Revetment 2	Revetment	Fair	Immediate maintenance
177	Heirisson Island Revetment 3	Revetment	Poor	Immediate maintenance
178	Heirisson Island Walling 1	Wall	Good	Immediate maintenance
179	Nile Street Revetment	Revetment	Good	None
180	East Perth Power Station Walling	Wall	Good	None
181	Claisebrook to Windan Bridge 13 Structures	Multiple Structures	Good	Immediate maintenance
182	Charles Patterson Park / Burswood Revetment 1	Revetment	Poor	Rebuild or remove
183	Causeway Block Wall 2	Wall	Good	None
184	Charles Patterson Park Retaining Wall	Wall	Good	None
185	Balbuk Way Timber Walling 1	Wall	Poor	Immediate maintenance
186	Belmont Racecourse Revetment	Revetment	Fair	None
187	Banks Reserve Revetment 1	Revetment	Fair	Immediate maintenance
188	Banks Reserve Revetment 2	Revetment	Good	Immediate maintenance
189	Banks Reserve Revetments 3	Revetment	Fair	None
190	Police Academy Tree Protection Timber Walling 1	Log wall	Poor	Immediate maintenance
191	Police Academy Tree Protection Timber Walling 2	Log wall	Poor	Rebuild or remove
192	Maylands Peninsula Floating Boat Ramp	Ramp	Non-retaining	None
193	Clarkson Reserve Revetment 1	Revetment	Fair	Rebuild

No.	Structure	Class	Retention	Recommended Works
194	Clarkson Reserve Historic Revetment 2	Revetment	Poor	Rebuild or remove
195	Maylands Yacht Club Log Wall	Log wall	Good	Immediate maintenance
196	Partially Removed Tranby Log Wall	Wall	Poor	Potential removal and revegetation
197	Tranby Log Wall 1	Log wall	Poor	Rebuild
198	Tranby Log Wall 2	Log wall	Poor	Rebuild or remove
199	Bath Street Reserve Concrete Bulkhead	Wall	Fair	Immediate maintenance
200	Redcliffe Bridge Abutment 1	Revetment	Fair	Rebuild
201	Hardey Park Revetment	Revetment	Fair	Immediate maintenance
202	Gabion Headwall for Drain	Gabion	Poor	Immediate maintenance
203	Belmont Cycle Path Revetment	Revetment	Fair	Immediate maintenance
204	Belmont Cycle Path Sheet Piling and Gabions	Revetment	Fair	Immediate maintenance
205	Balbuk Way Boat Launch Walling	Revetment	Good	Immediate maintenance
206	Redcliffe Bridge Abutment 2	Gabion	Good	None
207	Ascot Water Playground Jetty Timber Bulkhead	Wall	Fair	None
208	The Esplanade Historic Rubble / Rock Revetment	Armoured	Fair	Rebuild
209	The Esplanade Gabions	Gabion	Good	Immediate maintenance
210	Ascot Racecourse Historic Wall	Wall	Poor	Immediate maintenance
211	Ascot Racecourse Gabions and Wall	Wall	Poor	Rebuild
212	Ron Courtney Island Log Wall 1	Log wall	Poor	Rebuild or remove
213	Ron Courtney Island Revetment	Revetment	Fair	Immediate maintenance
214	Ron Courtney Island Log Wall 2	Log wall	Poor	Rebuild
215	Ron Courtney Island Log Wall 3	Log wall	Poor	Rebuild or remove
216	Garvey Park Historic Log Wall 1	Log wall	Poor	Potential removal and revegetation
217	Garvey Park Historic Log Wall 2	Log wall	Poor	Immediate maintenance
218	Garvey Park Kayak Club Walling	Wall	Good	Immediate maintenance
219	Garvey Park Kayak Club End Effect Mitigation	Armoured	Poor	Rebuild
220	Garvey Park Kayak Club Revetment	Revetment	Good	Immediate maintenance
221	Garvey Park Kayak Club Log Wall	Log wall	Fair	None
222	Garvey Park Wall 1	Wall	Fair	Immediate maintenance
223	Garvey Park Wall 2	Wall	Fair	Immediate maintenance
224	Ashfield Flats Revetment 1	Revetment	Good	None
225	Sandy Beach Reserve Bulkhead	Wall	Good	None
226	Sandy Beach Reserve Limestone Riprap and sedge	Armoured	Good	Immediate maintenance
227	Pickering Park Historic Jetties and Wall	Wall	Poor	Immediate maintenance
228	Helena Confluence Concrete Bag Revetment	Revetment	Good	None
229	Kings Meadow Oval Revetment	Revetment	Fair	Immediate maintenance
230	Kings Meadow Oval Timber Bulkhead	Wall	Good	Immediate maintenance
231	Guildford Temporary Concrete Bag Armouring	Armoured	Poor	Potential removal and revegetation
232	West Midland Pool Opposite Log Walling	Log wall	Poor	Potential removal and revegetation
233	Historic Pullman Park Railway Bridge Abutment	Wall	Poor	Potential removal and revegetation
234	Walyunga Pool Car Park Retaining Revetment	Revetment	Good	None
235	Fishmarket Reserve Boat Ramp	Ramp	Non-retaining	Rebuild
236	Guildford Grammar Concrete Bag Revetment	Revetment	Fair	Immediate maintenance
237	Guildford Grammar Historic Timber Walling	Wall	Poor	Rebuild
238	West Midland Pool Concrete Bulkhead	Wall	Fair	Rebuild or remove

No.	Structure	Class	Retention	Recommended Works
239	West Midland Pool Log Wall	Log wall	Poor	Potential removal and revegetation
240	John George Walk Trail Revetment	Revetment	Fair	Immediate maintenance
241	Viveash Sewerage Pipe Coir Logs	Wall	Fair	Potential removal and revegetation
242	Middle Swan Bridge Log Wall	Log wall	Poor	Potential removal and revegetation
243	Middle Swan Reserve Armouring	Revetment	Poor	Potential removal and revegetation

Table 7C Recommended works for foreshore protection structures along the Canning Foreshore

No.	Structure	Class	Retention	Recommended Works
244	Shelley Water Walkway Revetment	Revetment	Good	None
245	Kent Street Weir	Weir	Non-retaining	Immediate maintenance
246	Kent Street Weir Gabions	Gabion	Fair	Rebuild
247	Castledare Miniature Railway Wall	Wall	Fair	Potential removal and revegetation
248	Leach Highway Offramp Baffle Boards	Baffles	Fair	Rebuild
249	Shelley Sailing Club Wall	Wall	Good	None
250	Riverton Drive (Wadjup Point) Gabion Wall	Gabion	Good	Immediate maintenance
251	Shelley Bridge Water Supply Overflow Headwall	Wall	Good	None
252	Shelley Water Sloped Gabions	Gabion	fair	Immediate maintenance
253	Djarlgarra Bridge Abutment 2	Revetment	Good	None
254	Djarlgarra Bridge Abutment 1	Revetment	Fair	Immediate maintenance
255	Corrie Dale Place Upper Slope Armouring	Armoured	Fair	Potential removal and revegetation
256	Historic Railway Bridge Abutment	Log wall	Fair	None
257	Maddington Path and Drain Retaining Wall	Wall	Good	None
258	Ferres Road Bridge Abutment 1	Revetment	Good	Immediate maintenance
259	Ferres Road Bridge Abutment 2	Revetment	Good	Immediate maintenance
260	Tonkin Highway Bridge Abutment 1	Wall	Good	None
261	Tonkin Highway Bridge Abutment 2	Wall	Good	None

Appendix 8 Managing inundation

Table 8A Options for managing inundation and implications of each approach

Options	Implications
Raise ground levels	• Reduces foreshore amenity; • Very expensive when applied to large areas; • Requires a means for material retention.
Widen foreshore	• Reduces river amenity; • May restrict flows and increase flooding in some areas; • Requires a means for material retention, or program of renourishment.
Construct walling	• High capital cost and potential for ongoing maintenance; • Enhanced wave reflection and potential overtopping; • Consider need for wave recurve system.
Construct revetment	• High capital cost and some ongoing maintenance.
Do nothing	• Under expected climate change scenarios, the likelihood of flooding and inundation will increase; • Existing patterns of erosion or accretion need to be considered.

Appendix 9 Invasive species

Table 9A Invasive species (area in ha)

Species Name	Estuary	Swan	Canning	Total
Asparagus asparagoides	3.0	2.0	5.8	10.74
Anredera cordifolia	0.0	0.0	0.3	0.29
Arundo donax	3.8	12.7	6.6	23.04
Brassica tournefortii	6.4	0.0	0.0	6.42
Colocasia esculenta	0.0	0.1	1.1	1.16
Cardiospermum grandiflorum	0.0	0.0	0.3	0.31
Cortaderia selloana	0.1	14.8	3.0	17.85
Ehrharta calycina	10.3	27.7	30.5	68.46
Eichhornia crassipes	0.1	0.0	0.0	0.07
Eragrostis curvula	1.3	16.4	19.9	37.55
Echium plantagineum	0.0	16.6	5.1	21.66
Euphorbia terracina	3.0	0.5	1.0	4.55
Freesia alba x leichtlinii	0.0	0.0	0.1	0.07
Ferraria crispa	8.4	0.0	0.0	8.46
Gomphocarpus fruticosus	0.0	13.1	8.8	21.91
Hyparrhenia hirta	0.1	0.4	0.2	0.64
Hydrocotyle ranunculoides	0.0	0.0	0.1	0.10
Ipomoea indica	0.0	2.2	2.6	4.81
Juncus acutus	0.2	1.9	0.6	2.76
Lantana camara	0.2	1.3	2.1	3.59
Lupinus cosentinii	6.3	1.8	3.1	11.15
Lycium ferocissimum	0.0	0.0	0.0	0.00
Lonicera japonica	0.0	0.0	2.1	2.11
Leptospermum laevigatum	2.6	0.0	0.2	2.79
Lagurus ovatus	0.4	1.1	0.9	2.39
Lachenalia reflexa	4.1	0.0	0.0	4.09
Myriophyllum aquaticum	0.0	0.0	0.1	0.11
Moraea flaccida	0.6	4.9	7.2	12.81
Olea europaea	0.0	15.2	3.6	18.83
Oxalis pes-caprae	0.0	27.7	37.0	64.71
Pelargonium capitatum	2.8	0.1	0.8	3.75
Pennisetum setaceum	0.0	7.2	0.2	7.40
Ricinus communis	0.0	13.3	5.7	19.02
Romulea rosea	15.0	19.4	21.4	55.84
Rubus spp	0.0	13.2	49.9	63.12
Sparaxis bulbifera	0.0	0.4	0.0	0.38
Solanum linnaeanum	0.0	3.1	0.7	3.81
Sagittaria platyphylla	0.0	0.4	0.0	0.38
Schinus terebinthifolia	0.0	8.9	14.4	23.36
Tamarix aphylla	0.0	0.0	0.3	0.31
Typha orientalis	5.1	40.5	27.6	73.21
Watsonia meriana	0.4	104.7	48.3	153.41
Zantedeschia aethiopica	0.1	4.5	13.7	18.28

Appendix 10 Summary of Local Government Authority statistics for vegetation

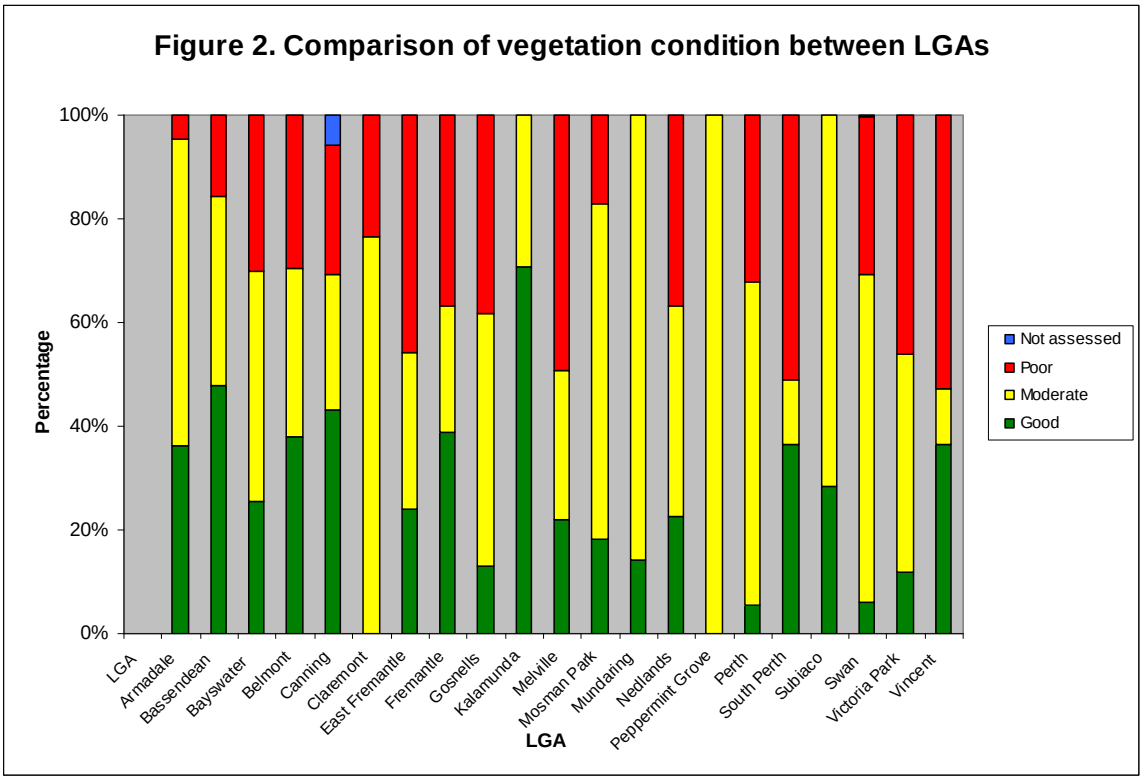


Figure 10A Comparison of vegetation condition across Local Government Authorities

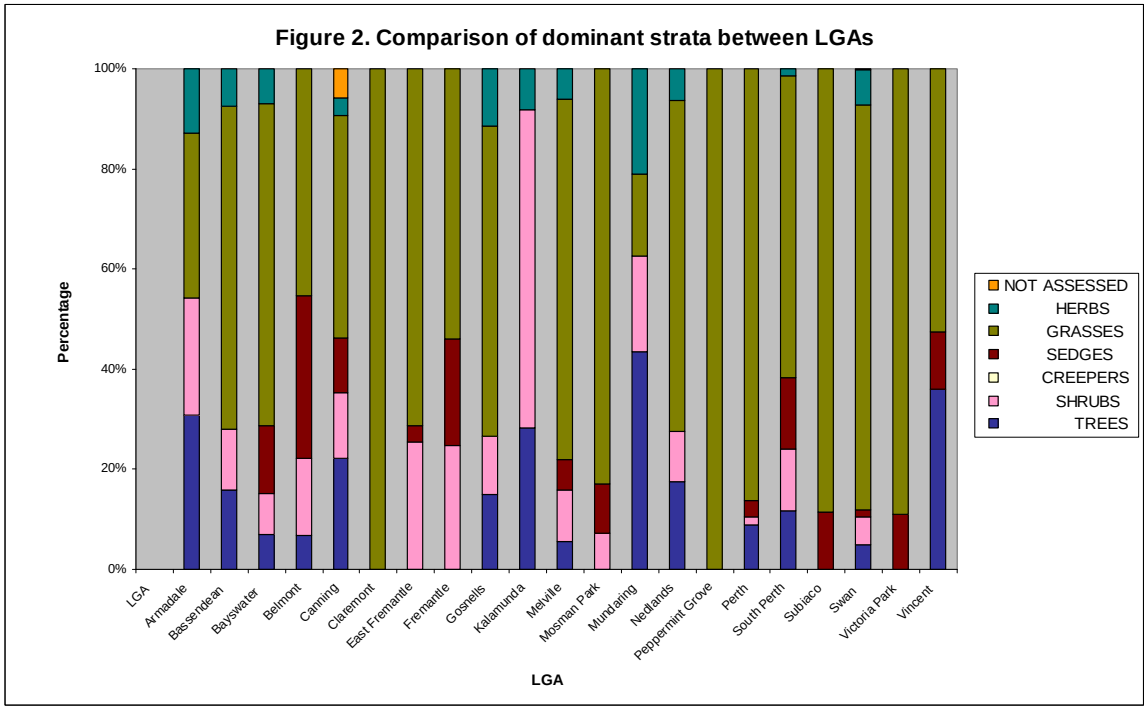


Figure 10B Comparison of dominant strata across Local Government Authorities