GOVERNMENT OF WESTERN AUSTRALIA

Department of **Biodiversity, Conservation and Attractions**

PARKS AND WILDLIFE SERVICE

Saint Leonards Creek Foreshore Condition Assessment

Version: 2 Approved by: Peter Adkins

Last Updated: November 2020

Custodian: Rivers and Estuaries Branch Review date: 01/12/2030

Version number	Date approved DD/MM/YYYY	Approved by	Brief Description
1.1	4/09/2020	Debbie Besch	Version for stakeholders
1.2	15/09/2020	Debbie Besch	Final Draft for stakeholders
2.1	26/11/2020	Debbie Besch	Final

GOVERNMENT OF WESTERN AUSTRALIA

Department of **Biodiversity, Conservation and Attractions**

PARKS AND WILDLIFE SERVICE

Saint Leonards Creek Foreshore Condition Assessment

April 2019

July 2020

November 2020

Parks and Wildlife Service
Department of Biodiversity, Conservation and Attractions
Locked Bag 104
Bentley Delivery Centre WA 6983
Phone: (08) 9278 0900
Fax: (08) 9219 9967

dbca.wa.gov.au

November 2020

This report was prepared by Alison McGilvray.

Questions regarding the use of this material should be directed to:

Healthy Catchments Program
Rivers and Estuaries Branch
Department of Biodiversity, Conservation and Attractions
Locked Bag 104
Bentley Delivery Centre WA 6983
Phone: 08 9278 0900
Email: rivers.systems@dbca.wa.gov.au

The recommended reference for this publication is:

Department of Biodiversity, Conservation and Attractions, 2020, *Saint Leonards Creek Foreshore Condition Assessment*, Department of Biodiversity, Conservation and Attractions, Perth.

This report is available in alternative formats on request.

Cover images:

Top: *Lepidosperma longitudinale* sedgeland on a proposed residential estate in Brabham prior to clearing, April 2019 (Alison McGilvray/DBCA).

Below: Photo taken from the same viewpoint of the *Lepidosperma longitudinale* sedgeland after clearing, July 2020 (Alison McGilvray/DBCA).

Contents

Appendices

Acknowledgments

We acknowledge the Noongar people as the original custodians of south-western WA, and the Whadjuk people as the traditional owners of the lands and waters of Saint Leonards Creek.

The tributary assessment project is an initiative of the Healthy Catchments Program within Department of Biodiversity, Conservation and Attractions' (DBCA) Rivers and Estuaries Branch. The field assessment of Saint Leonards Creek was carried out by Alison McGilvray from DBCA and Melinda McAndrew from the City of Swan.

Patrick Maslen and Leah Botten from DBCA set up the data collection system and Patrick has provided data management, GIS support and maps for this report.

North Metropolitan (North Metro) TAFE conducted water monitoring of eight sites in the creek system and provided their results and observations.

Josh Baker from DBCA's Rivers and Estuaries Science Unit analysed water monitoring data collected by North Metro TAFE.

Thank you to Department of Communities and City of Swan for providing comment and feedback on this report.

Summary

Saint Leonards Creek is a seasonal tributary to the Swan River, located in the north-east of the Perth metropolitan area in the City of Swan. Saint Leonards Creek Catchment is within the City of Swan's Urban Growth Corridor and has undergone substantial urbanisation, with more planned in the near future (SRT, 2011; City of Swan, 2019).

Saint Leonards Catchment was identified as a catchment of concern by DBCA through modelling completed for the Swan Canning Water Quality Improvement Plan (WQIP) 2009. Subsequently, a local WQIP was developed in 2011 for Saint Leonards Creek Catchment, setting aspirational targets for land managers to address water quality issues in the catchment.

The creek was assessed by DBCA and the City of Swan from November 2018 to April 2019. The purpose was to determine the current condition of riparian vegetation and banks using recognised foreshore condition assessment methods.

Much of Saint Leonards Catchment has been used for rural and semi-rural purposes, such as grazing or equine small holdings. Riparian vegetation has been disturbed along most of Saint Leonards Creek as a result of land practices. Most of the riparian vegetation across Saint Leonards Creek is in poor condition.

The few areas with good condition vegetation are in the suburb of Brabham and proposed for residential development, so it is essential that riparian values are retained during development.

A separate report has been completed for Lots 352-355 on Murray Road Brabham, which are vested in Department of Communities (DoC) and planned for residential development. This area contained the best condition vegetation, and the report provides recommendations for its protection.

Most of Saint Leonards Creek is located on private property, or on a narrow easement vested in the City of Swan. Letters were sent seeking permission to access properties to undertake the assessment. Many landholders were supportive of the assessment and provided valuable information about the history of the creek and its changing values.

Many landholders were interested in the creek and wanted to protect its wildlife but were not aware which plants were weeds or natives, or what a natural creek ecosystem would look like. Several landholders run horses, with paddocks intersecting the creek. Providing further information and education is critical to engaging landholders in more active management and protection of the creek. There is an opportunity for the City of Swan to provide some of this information to new landholders when properties are sold.

Recommendations

Overall, 21.5km of stream bank was assessed. Recommendations from DBCA's Rivers and Estuaries Branch across the creek system are to:

- Maintain hydrological function of tributaries and associated wetland systems;
- Remove weed species currently low in number that threaten downstream values, especially species known as prolific spreaders;
- Ensure that vegetative material from invasive weeds is not spread further during development;
- Address sedimentation and water quality issues through engagement and negotiation with landholders, developers and the City of Swan;
- Protect Whadjuk cultural values of the creek and provide opportunities to engage Noongar people in restoration activities through engaging Noongar businesses and Traditional Owners who can speak for this country; and
- Provide education material and workshops to residents to promote low fertiliser use in their gardens and the value of native plants and animals, as well as identification of invasive weed species.

For ease of reporting the creek has been split into three assessment zones.

1. Swan Valley Planning Act *area*

Located to the east of Murray Road and the proposed Henley Brook Avenue. The zone includes most of West Swan and part of the suburb of Henley Brook. The City of Swan plans to retain rural landuses for heritage and tourism.

The creek system is made up of several defined channels in this zone. Many landholders have added exotic species to remnant vegetation such as Willows and other deciduous trees. *Isolepis prolifera* was also found in nearly every segment

north of Lawson Road and is a concern because it has the potential to spread rapidly.

Many properties adjacent to the creek are small horse hobby farms. Where horses have access to the creek the riparian understorey has been cleared and contains almost no native vegetation.

Landholders were offered the opportunity to undertake restoration work with funding from DBCA. Six landholders took up this offer and have become engaged in revegetation and weed control.

Recommendations for this zone:

- Continue to support landholders restoring the creekline on their properties and monitor native plant survival and weed invasion;
- Engage with other landholders if they express an interest in restoration;
- Restore priority sections of City of Swan easements;
- Address sedimentation and water quality issues along Lawson Road;
- Provide education material to horse owners on managing manure and other fertilisers, and providing safe stock watering that does not impact on the creek; and
- Remove *Isolepis prolifera* north of Lawson Road before it establishes in the lower reaches of the creek.

2. Henley Brook development area

Located north of Park Street and west of the proposed Henley Brook Avenue. The headwaters of the north-south creek alignment are located in Morgan Fields residential estate, completed in 2002.

Most of the zone is currently rural and made up of small hobby farms, but most properties have been bought by developers and are intended for residential development.

Riparian vegetation is almost absent in this zone. This is due in part to clearing for farming activities but also as the creek has been modified into straight drainage channels. Very little water runs through the drainage channels so wetland dependent vegetation cannot survive. Consequently nearly all vegetation was in poor condition.

Recommendations for this zone:

- Engage with district and local structure planning processes to ensure that drainage is in accordance with water sensitive urban design and that creek or drainage channel buffers are revegetated with local native plants;
- Ensure revegetated and conservation areas are clearly delineated using footpaths, bollards, roads or fencing to prevent parkland or surrounding landuse encroaching into these areas;
- Provide opportunities for future residents to connect to nature by installing pathways around riparian vegetation, wildlife hides, and boardwalks or viewing platforms in sensitive areas. Provide interpretive information on the

natural values in relation to the broader catchment and its connection to the Swan River; and

- Retain well-established local native trees, and non-local Eucalyptus trees that are not outcompeting native plants, to reduce temperatures and provide shade and fauna habitat in new residential developments.

3. Brabham development area

Located west of Murray Road and south of Park Street, including new residential estates Whiteman Edge, Ariella, Avonlee and Flamewood.

This was the only zone where good condition vegetation was found. However, it is located on land proposed for residential development or has been cleared since the assessment. Remnant vegetation has been impacted by past land practices but in areas has regenerated to good condition.

In particular, several segments on DoC land have high diversity with dominant genera including *Corymbia, Astartea, Lepidosperma* and *Baumea*. Given the overall degraded nature of Saint Leonards Creek, this vegetation is highly valuable and should be protected. Remnant stands of *Xanthorrhoea brunonis* also occur on DoC land. With revegetation, weed and access control, areas in average condition will regenerate and can be restored to good condition.

On DoC land, a drain outlet from Dreng Park is a major source of weeds (*Isolepis prolifera*, Spear thistle, various grasses) to downstream high value areas and is a priority for management.

No good condition vegetation was found where urban development has taken place. Palusplain wetlands that are now mostly redeveloped into residential estates have been modified into constructed drainage channels disconnected to the creek system. Several segments in Whiteman Edge Estate were under development and contained almost no native vegetation. Most segments in the proposed Ariella Estate had extensive weed cover due to historic clearing and farming.

Recommendations for this zone:

- Address hydrological issues in Watervalley Boulevard Park (Resource Enhancement Wetland 8805) resulting from construction of a concrete footpath and revetment through the wetland;
- Retain Pannage Wetlands (Resource Enhancement Wetland 8804), connecting vegetation, and the riparian corridor on DoC land;
- Re-evaluate riparian vegetation on DoC land under *A methodology for the evaluation of wetlands on the Swan Coastal Plain, Western Australia* (DBCA 2017) to ensure conservation values are identified and appropriate buffers are applied [note that Pannage Wetlands has been re-evaluated since the assessment];
- Remove invasive species from the drain in Dreng Park in Brabham;
- Translocate *Lepidosperma longitudinale* and *Xanthorrhoea brunonis* plants that are to be cleared to suitable areas within Saint Leonards Catchment;

- Prevent existing weeds from being further disbursed during the construction phase of development;
- Control weedy grasses and herbs that are starting to outcompete natives in Savello Park in Whiteman Edge;
- Engage with district and local structure planning processes to ensure that adequate buffers are applied to the creek and remnant vegetation is retained;
- Ensure areas of conservation value are clearly delineated using footpaths, bollards, roads or fencing to prevent parkland or surrounding landuse encroaching into high value conservation areas; and
- Provide opportunities for future residents to connect to nature by installing pathways around riparian vegetation, wildlife hides, and boardwalks or viewing platforms in sensitive areas. Provide interpretive information on the natural values in relation to the broader catchment and its connection to the Swan River.

Specific recommendations can be found in Appendix 1.

1 Introduction

Saint Leonards Creek is a seasonal tributary to the Swan River, located in the suburbs of Henley Brook, Brabham and West Swan in Perth's Swan Valley (Figure 1). It has several branches and only flows for a few months each year dependent on rainfall. Its catchment is 11.6 square kilometres in size (SRT 2011).

Saint Leonards Creek Catchment is within the City of Swan's Urban Growth Corridor and has undergone substantial urbanisation, with more development planned in the near future (SRT, 2011; City of Swan, 2019).

The creek's headwaters consist of several branches in the semi-rural suburb of Henley Brook and the densely urban area of Brabham. In Brabham, the creek has been modified for residential development or is in areas proposed for development (City of Swan 2019).

Parts of Henley Brook are also proposed for residential development and many semi-rural lifestyle properties have already been sold to developers.

Saint Leonards Creek flows into the Swan River in West Swan. The section in West Swan and the eastern part of Henley Brook is not proposed for further development under the *Swan Valley Planning Act 1995*. The Swan River and some adjacent lands are located in the Swan Canning Development Control Area (DCA) (Figure 1). Besides the confluence of Saint Leonards Creek with the Swan River, the creek is not located within the Swan Canning DCA. Under the Metropolitan Region Scheme, DBCA (as delegate of the Swan River Trust) provides advice on developments that may affect the waters of the Swan Canning DCA. Urban developments adjacent to Saint Leonards Creek may affect the waters of the DCA, so DBCA can provide advice on future developments.

Saint Leonards Creek was assessed by DBCA and the City of Swan from November 2018 to April 2019. The purpose was to determine the current condition of riparian vegetation and banks using recognised foreshore condition assessment methods.

1.1 Water quality issues

Water quality is monitored fortnightly on the lower reaches of the creek, about 500m upstream from its outflow to the Swan River. This is part of a long-term monitoring program of the Swan and Canning rivers and selected tributaries by Department of Water and Environmental Regulation (DWER) and DBCA. The program enables annual reporting on compliance against long- and short-term water quality targets (DWER 2018).

An additional four sites along Saint Leonards Creek were monitored between 2002 and 2008 as part of a Local WQIP. Sampling identified moderate nitrogen and phosphorus levels and high concentrations of non-nutrient contaminants (heavy metals: aluminium, chromium, copper, iron, manganese and zinc). It was determined that the land use making the greatest contribution to the nutrient load

were farms and hobby farms, which were estimated to contribute 98% of the total nitrogen load and 52% of the phosphorus load (SRT, 2011).

The 2018 Saint Leonards Catchment Nutrient Report Card showed that the site on the lower reaches of the creek was failing in both the short- and long-term nutrient targets for total nitrogen and failing the long-term targets for total phosphorus (DWER, 2019).

Long-term landowners adjacent to Saint Leonards Creek mentioned foul-smelling sludge occasionally flowing down the creek, sedimentation, reduced flows and reduced fauna sightings including of turtles and freshwater crayfish (pers comm M McAndrew City of Swan and A McGilvray DBCA).

1.2 Assessment objectives

Objectives of the foreshore condition assessment were to:

- determine riparian vegetation condition;
- identify significant points of erosion;
- identify management issues including uncontrolled access, weed incursion and vegetation loss;
- determine recommendations for restoration activities; and
- provide a baseline for future assessments.

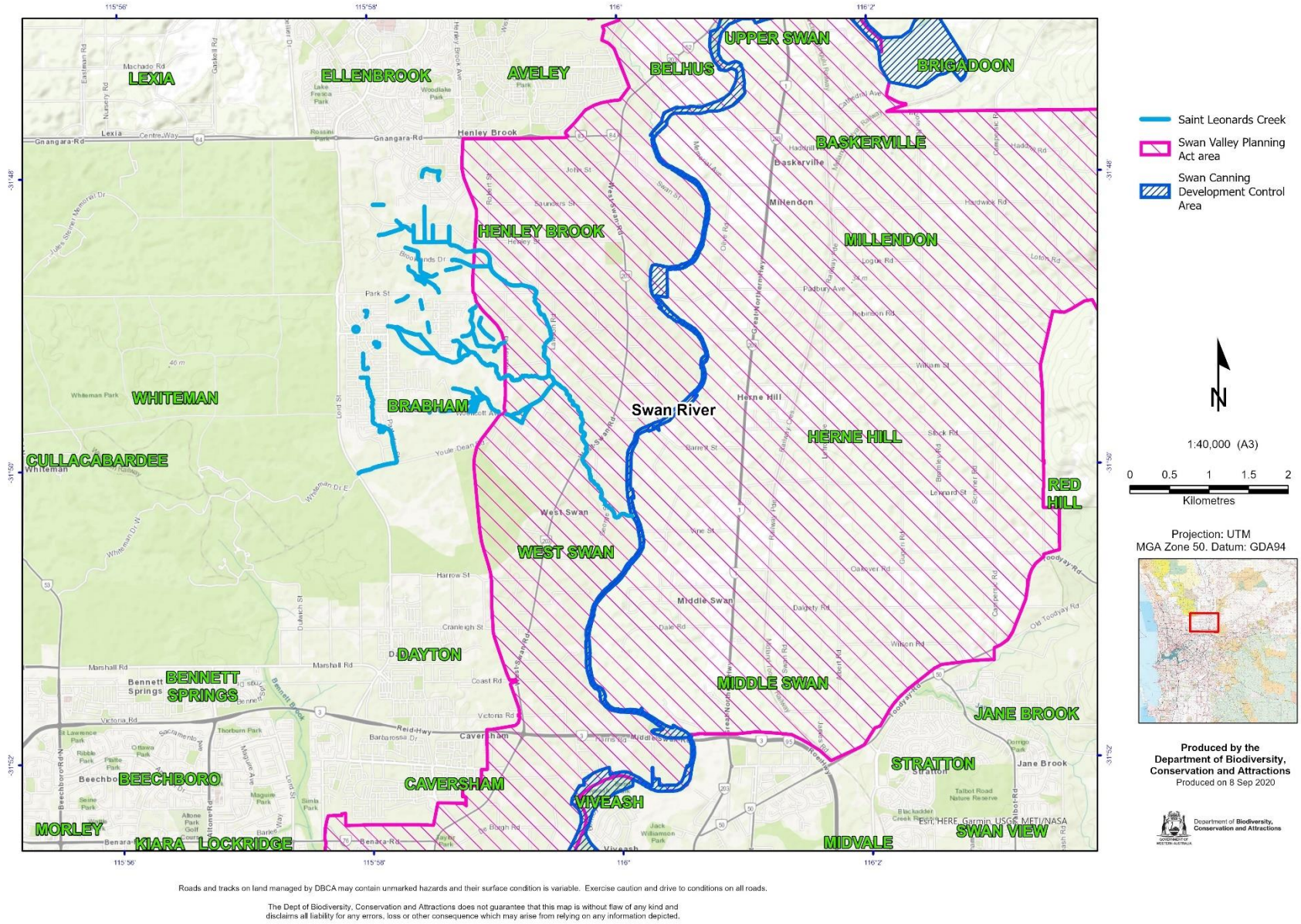


Figure 1: The location of Saint Leonards Creek in relation to the Swan River, the Swan Canning Development Control Area, and the Swan Valley Planning Act 1995 *area.*

2 Methodology

2.1 Condition assessment

The assessment of Saint Leonards Creek extended from the confluence with the Swan River in West Swan to the headwaters of the creek in Brabham and Henley Brook (Figures 1 and 2). Where the creek's alignment is modified in residential estates in Brabham, drainage channels in public open space were assessed.

The assessment methodology was based on a 2006-2007 project by DBCA and DWER, where 37 tributaries of the Swan Canning Catchment were assessed (SRT 2008). While Saint Leonards Creek was not included in these assessments, for consistency the same methodology was used.

2.1.1 Desktop

A brief desktop assessment was undertaken to note the recorded natural and cultural values adjacent to Saint Leonards Creek. A 500m buffer to the river's alignment was applied and a search for the following data was conducted:

- Nationally Important Wetlands;
- Bush Forever sites;
- Environmentally Sensitive Areas declared under the *Environmental Protection Act 1986*;
- known populations of rare or priority flora and fauna;
- State and nationally listed threatened ecological communities (TECs); and
- registered Aboriginal sites.

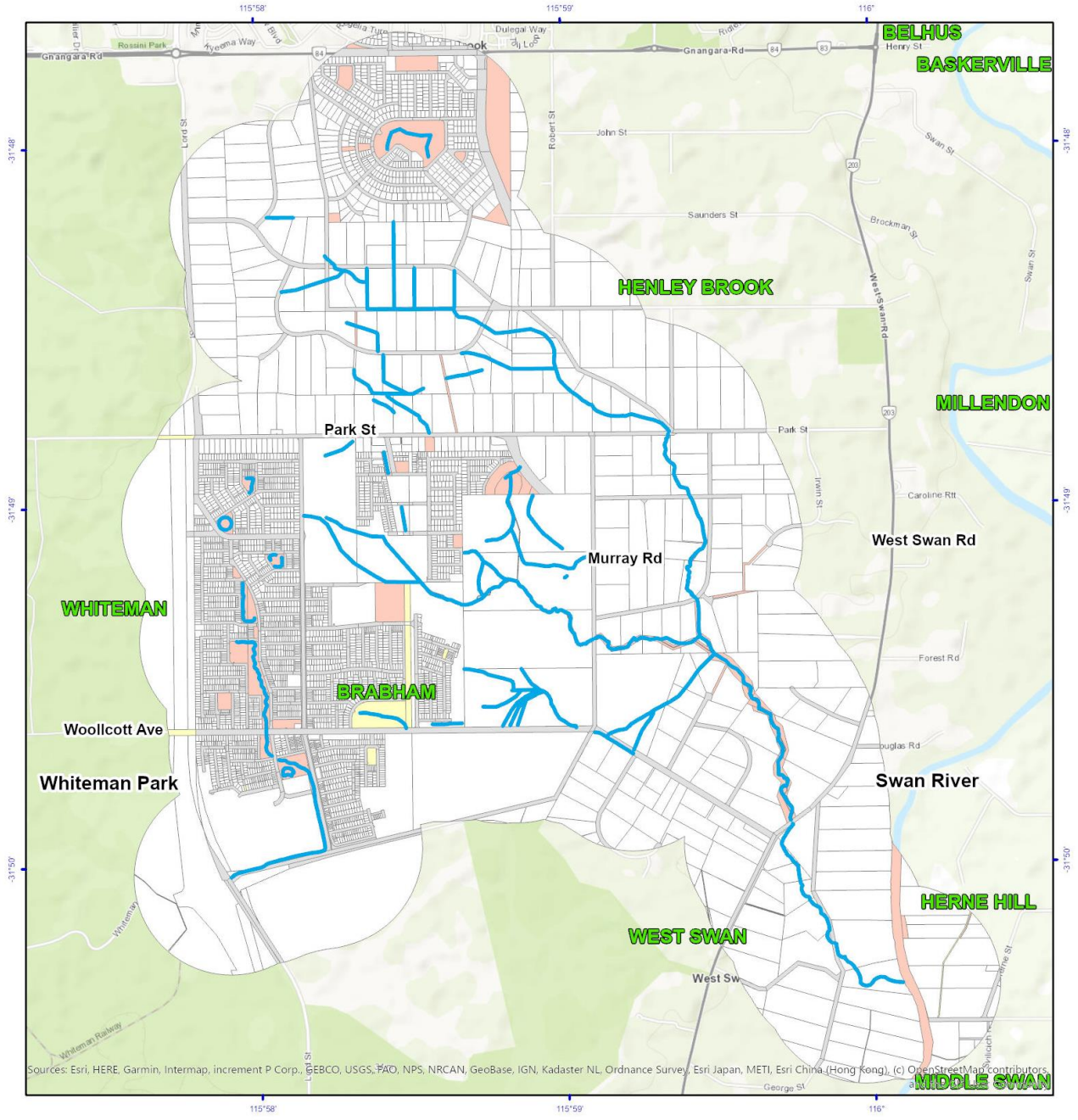
2.1.2 Field

Most of the creek is located on private property or on a narrow easement vested in the City of Swan (Figure 2). DBCA and the City of Swan sought permission from landholders to access their properties or where it was necessary to cross private property to access the easement. Where landholders did not grant access, a visual assessment was made from the nearest access point.

The ArcGIS *GIS Collector* application was used to collect field data on an iPhone. The alignment of Saint Leonards Creek was digitised from aerial photography and verified in the field in *GIS Collector*.

The stream bank was split into segments based on similarity of vegetation structure, bank type and land use. Both sides of the creek were assessed as one segment. Attributes were assigned to left and right banks. Left and right banks were determined when facing downstream.

Categories for bank stability, vegetation condition and management issues were adapted from the Foreshore Condition Assessment Form (Pen and Scott 1999). A Pen and Scott (1995) grade was given for each segment. Refer to Appendix 11 for details of all field attributes collected.



Cadastre

- Freehold
- State Forest/Timber Reserve
- Crown Reserve
- Marine Park
- Reserve / Lease
- Leases
- UCL
- Public Roads/Other Public Lands
- Water
- St Leonards Creek

N

1:20,000 (A3)

0 250 500 750 1,000

Meters

Projection: UTM
MGA Zone 50. Datum: GDA94

Department of Biodiversity, Conservation and Attractions

Produced by the Department of Biodiversity, Conservation and Attractions 19 Aug 2020

Roads and tracks on land managed by DBCA may contain unmarked hazards and their surface condition is variable. Exercise caution and drive to conditions on all roads.

The Department of Biodiversity, Conservation and Attractions does not guarantee that this map is without flaw of any kind and disclaims all liability for any errors, loss or other consequence which may arise from relying on any information depicted.

Figure 2: Land tenure across the extent of Saint Leonards Creek. Note that where the creek's alignment has been modified in Brabham and Henley Brook, drainage channels were assessed.

2.1.3 Categorisation of segments

Segments were categorised based on the Cooperative Research Centre (CRC) of Catchment Hydrology's framework (Rutherfurd et al., 2000a and 2000b). The CRC developed a 'reach priority shuffle' method (Appendix 10) to rank segments or reaches according to five parameters:

- rarity or conservation value (rare/nationally or regionally significant);
- condition (good-poor);
- trajectory (deteriorating-improving) and hope (with or without);
- proximity to good reaches; and
- ease of rehabilitation (easy-hard).

See Appendix 9 for a description of these parameters.

Each segment was assigned a category for recommended restoration strategies (Table 1). This prioritised segments and highlighted areas of stream bank for restoration. Once these areas were identified additional factors were considered, including community interest, capacity and education and recreation benefits.

Table 1: Criteria for assigning a category to a segment and the suggested management strategy for each category.

Category	Criteria and management strategy
0	**Condition and pressures** Pen and Scott grade = A1; Level of pressure = Minimal; and none of the following issues were recorded for the segment: o Access – vehicle, people, stock, or 'other' o Loss of vegetation – through trampling, grazing, displacement by weeds, clearing, erosion o Erosion – undermining, large deposits, incised scour, scarps/vertical shears, slumped banks, embayment retreat, exposed tree/shrub roots o Other management issues **Strategy: Only requires monitoring for the emergence of new threats in the future**

1	**Rarity or conservation value** Segments intersect with or are within 500m of one or more of the following: ○ Nationally Important Wetland ○ Bush Forever site ○ Environmentally Sensitive Area ○ Known populations of rare or priority flora and fauna ○ State or nationally listed threatened ecological community **Strategy: Protection or minor restoration to maintain conservation value and condition**
2	**Condition** Pen and Scott grade = A1, A2 or A3 but segment does not meet criteria for Category 1 **Strategy: Protection or minor restoration to maintain good condition**
3	**Condition and trajectory** Pen and Scott grade = B1, B2, B3, C1 or C2 and Trajectory = Deteriorating **Strategy: Restoration to prevent further deterioration**
4	**Condition, trajectory and proximity to good reaches** Pen and Scott grade = B1, B2, B3, C1 or C2; Trajectory = Stable / improving, and the segment abuts another segment that meets Pen and Scott grade A1, A2 or A3 **Strategy: Expansion of good quality segments by restoring abutting segments in poorer condition**
5	**Condition, trajectory, proximity to good reaches and ease of rehabilitation** Pen and Scott grade = B1, B2, B3, C1 or C2; Trajectory = Stable / improving; the segment does not abut another segment that meets Pen and Scott grade A1, A2 or A3, and Ease of rehabilitation = Easy **Strategy: A small investment in restoration works to stimulate natural recovery**

6	**Condition, trajectory, proximity to good reaches and ease of rehabilitation** Pen and Scott grade = B1, B2, B3, C1 or C2; Trajectory = Stable / improving; the segment does not abut another segment that meets Pen and Scott grade A1, A2 or A3, and Ease of rehabilitation = Hard **Strategy: Restoration is a lower priority as investment of resources is likely to be high, although there is a potential for recovery**
7	**Condition and hope** Pen and Scott grade = C3, D1, D2 or D3 and Hope = without hope **Strategy: Low priority for restoration as these areas are likely to be expensive and difficult to rehabilitate**
8	**Condition and hope** Pen and Scott grade = C3, D1, D2 or D3 and Hope = with hope **Strategy: Lowest priority for restoration as these areas are likely to be expensive and difficult to rehabilitate, and there is some chance of natural recovery if no action is undertaken**

2.2 Landholder consultation

Letters from the City of Swan were sent to landholders in October 2018 notifying them of the assessment and seeking permission to access their land.

The letters were followed up with phone calls during which additional information landholders provided about the creek was recorded, including changes over time and wildlife observations.

After the assessment, landholders were sent a thank you letter for their cooperation. An information sheet was provided for landholders in the *Swan Valley Planning Act* area, which included major observations from the assessment, actions they could undertake to protect the creek and where to access further information (see example in Appendix 3).

Landholders in the *Swan Valley Planning Act* area with no easement over the creek were offered the opportunity to undertake restoration activities with funding from DBCA. Landholders with an easement were not eligible for DBCA funding but were offered assistance to apply for other grants if they were interested.

2.3 Water monitoring

As a complementary project to the assessment, North Metro TAFE monitored eight sites in Saint Leonards Catchment in Semester 1 2019 (Figure 3).

Physical parameters measured included pH, Temperature (ºC), Conductivity (µS/cm), Dissolved Oxygen (% and mg/L), Oxygen Redox Potential (mV) and Turbidity (NTU). Metal analysis (ppm) included copper, lead, zinc and cadmium in sediment. Bacteria (coliform) and algae species were also measured.

The physical measures were monitored monthly in February and March, then twice in May 2019. The metal and bacteria analyses were measured once in 2019 (G Dolva, 2019 North Metro TAFE).

Four replicates were taken at each site amongst the student groups. Physical measures were taken using two different monitoring probes: a Cyberscan 463 and a YSI-2 unit. The probes were calibrated prior to use against standard solutions.

The metal and bacteria analytes were taken using a grab sample in standard solution bottles for those metals in accordance with standard operating procedures outlined in Field Sampling Guidelines, Department of Water, 2009. Samples were chilled and returned to the TAFE laboratory for analysis (G Dolva, 2019 North Metro TAFE).

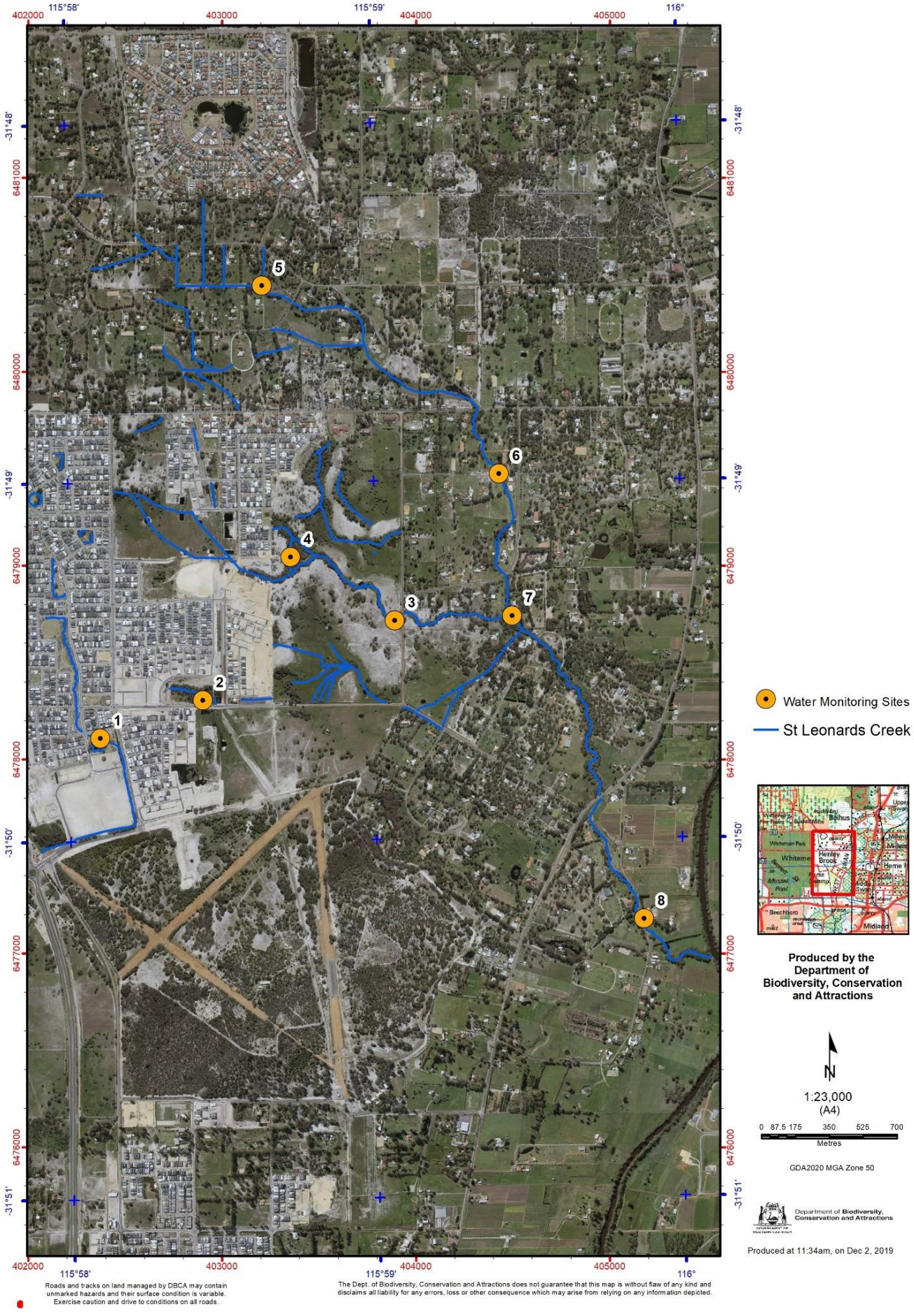


Figure 3: North Metro TAFE Water quality monitoring sites on Saint Leonards Creek.

3 Results

3.1 Condition assessment

Overall, 21.5km of stream bank was assessed (Table 2). For ease of reporting the creek was split into three assessment zones:

- The *Swan Valley Planning Act* area is located to the east of Murray Road and the proposed Henley Brook Avenue. It includes most of West Swan and part of Henley Brook. The City of Swan plans to retain rural landuses for heritage and tourism purposes. Urban infill is not planned for this area.
- The Henley Brook development area is north of Park Street and west of the proposed Henley Brook Avenue. Most of the current landuse is rural and many properties are small hobby farms, but most of these properties have been bought by developers and are intended for residential development.
- Much of the Brabham development area has been developed into high density residential estates or will be developed in the near future (Figure 4).

Table 2: Length of streambank assessed, number of segments and average segment length within the assessment zones.

Assessment zone	Length assessed (km)	Number of segments	Average segment length (m)
Swan Valley Planning Act area	6.36	32	199
Henley Brook development area	5.09	24	212
Brabham development area	10.01	36	278
Total	**21.46**	**92**	**233**

Much of the *Swan Valley Planning Act* area has been used for dairy farming, fruit growing and viticulture since early European settlement, due to the flat landform and access to the Swan River. Many vineyards are still present on the lower reaches of Saint Leonards Creek although dairy farming and commercial fruit growing are less common (Figure 5).

The Henley Brook development area is currently nearly all in private ownership but is allocated for dense residential development with local structure planning processes in progress. Segments 91 and 92 are located on public open space in Sandown Park in the Morgan Fields estate.

The western part of Brabham has already been developed into dense residential estates, with the creek system modified into open drainage channels or piped. A significant area on the eastern part is vested in DoC.

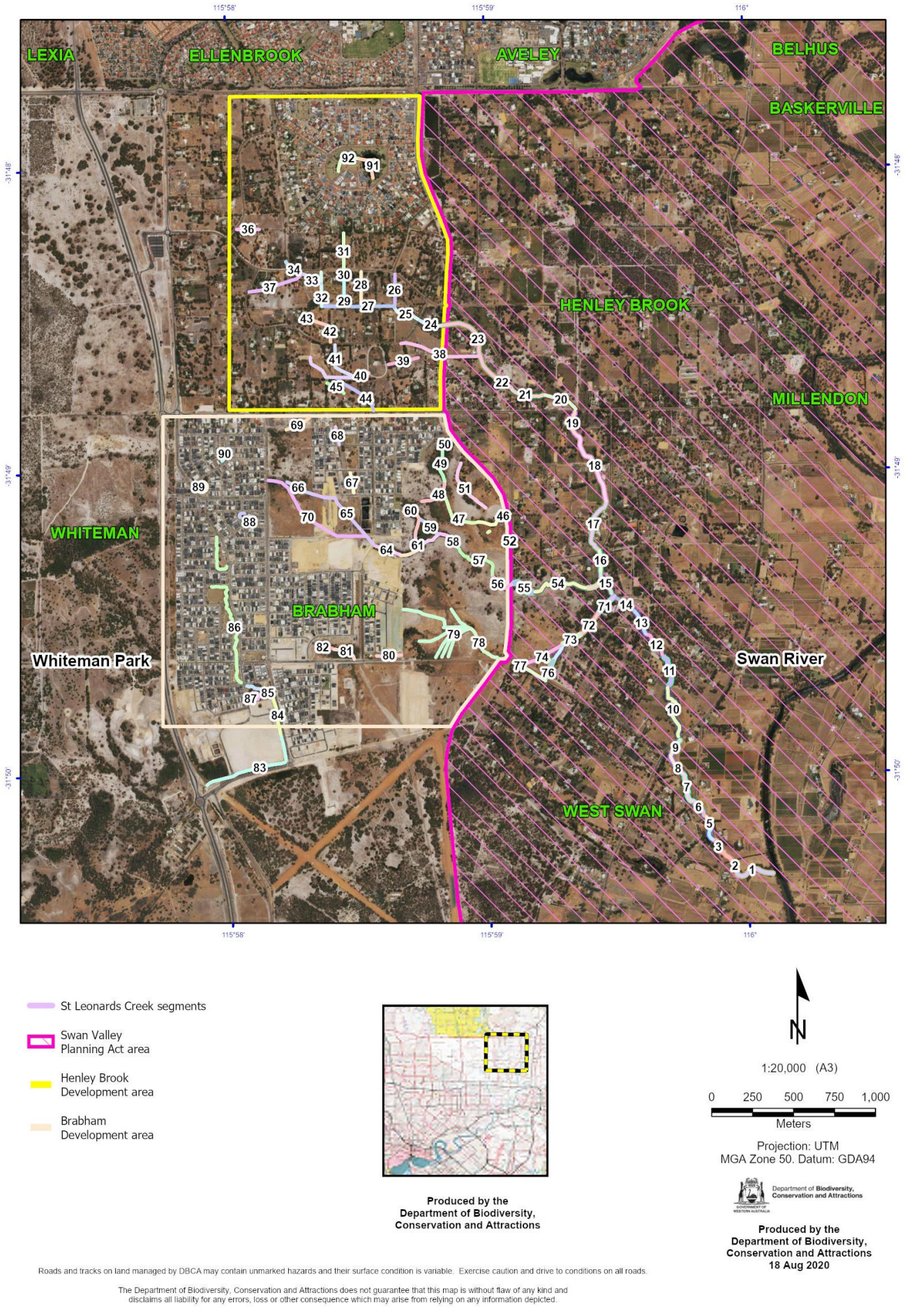


Figure 4: Segments identified on Saint Leonards Creek within the three assessment zones.

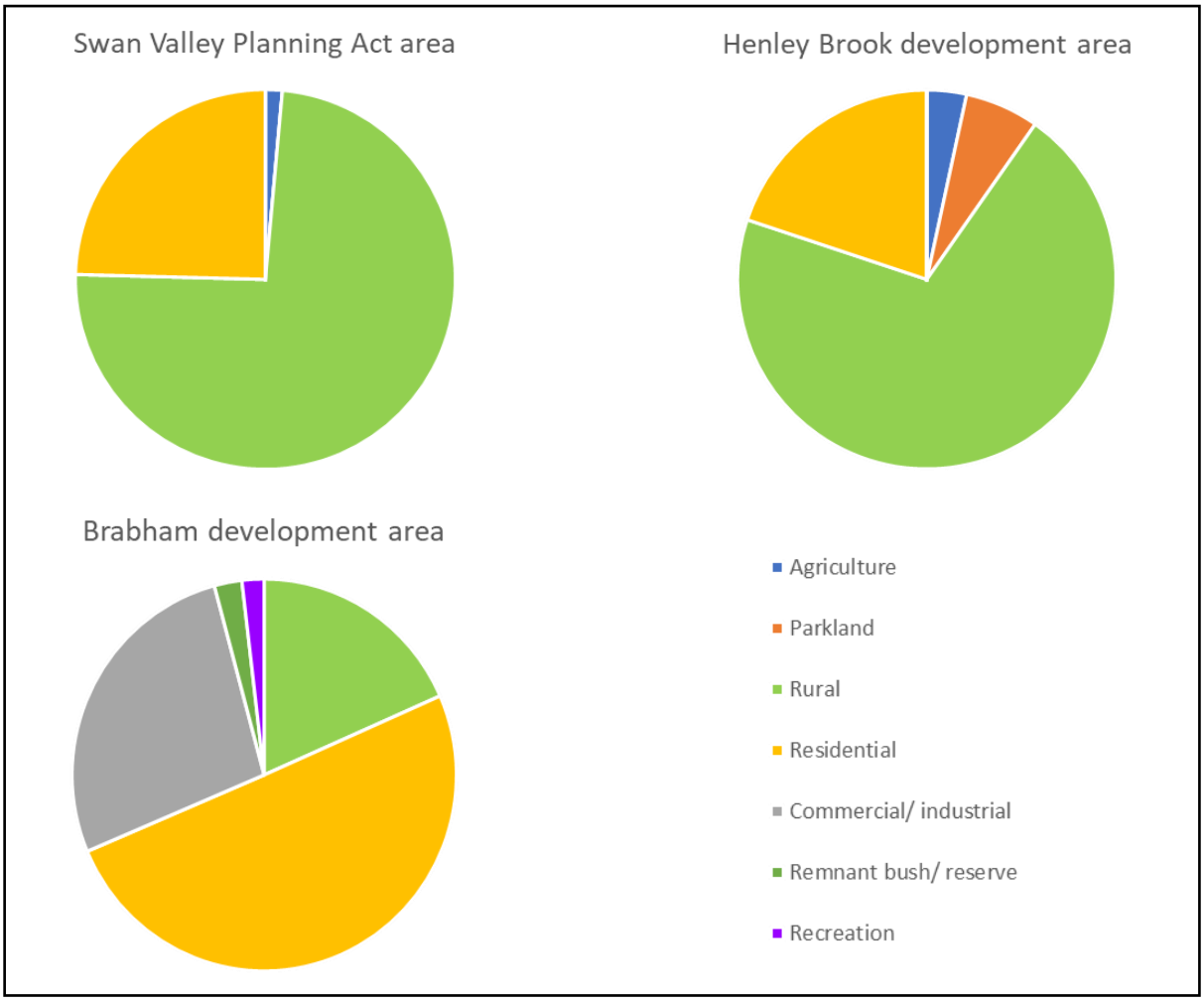


Figure 5: Landuses within each assessment zone.

Appendix 1 contains information on each segment, including a photo, vegetation description and recommendation for restoration.

3.1.1 Bank features and stability issues

The headwaters of Saint Leonards Creek consist of multiple branches flowing from the suburbs of Henley Brook and Brabham. A major channel is roughly aligned north-south and flows from the upper parts of the suburb of Henley Brook. Two channels also flow in from Brabham and join the north-south alignment of the creek near Lawson Road in lower Henley Brook.

Landform at the headwaters is flat and it is likely that the creek had many associated palusplain wetlands, some of which remain in undeveloped parts of Brabham, but most have been cleared and the drainage has been modified into a series of ditches.

Bank stability is good to average across most of the creek system (Figure 6). It is important to note that bank stability was considered independently of weed cover, so the bank may be stabilised by weeds. If weed control works are planned, the impact on bank stability needs to be considered and addressed.

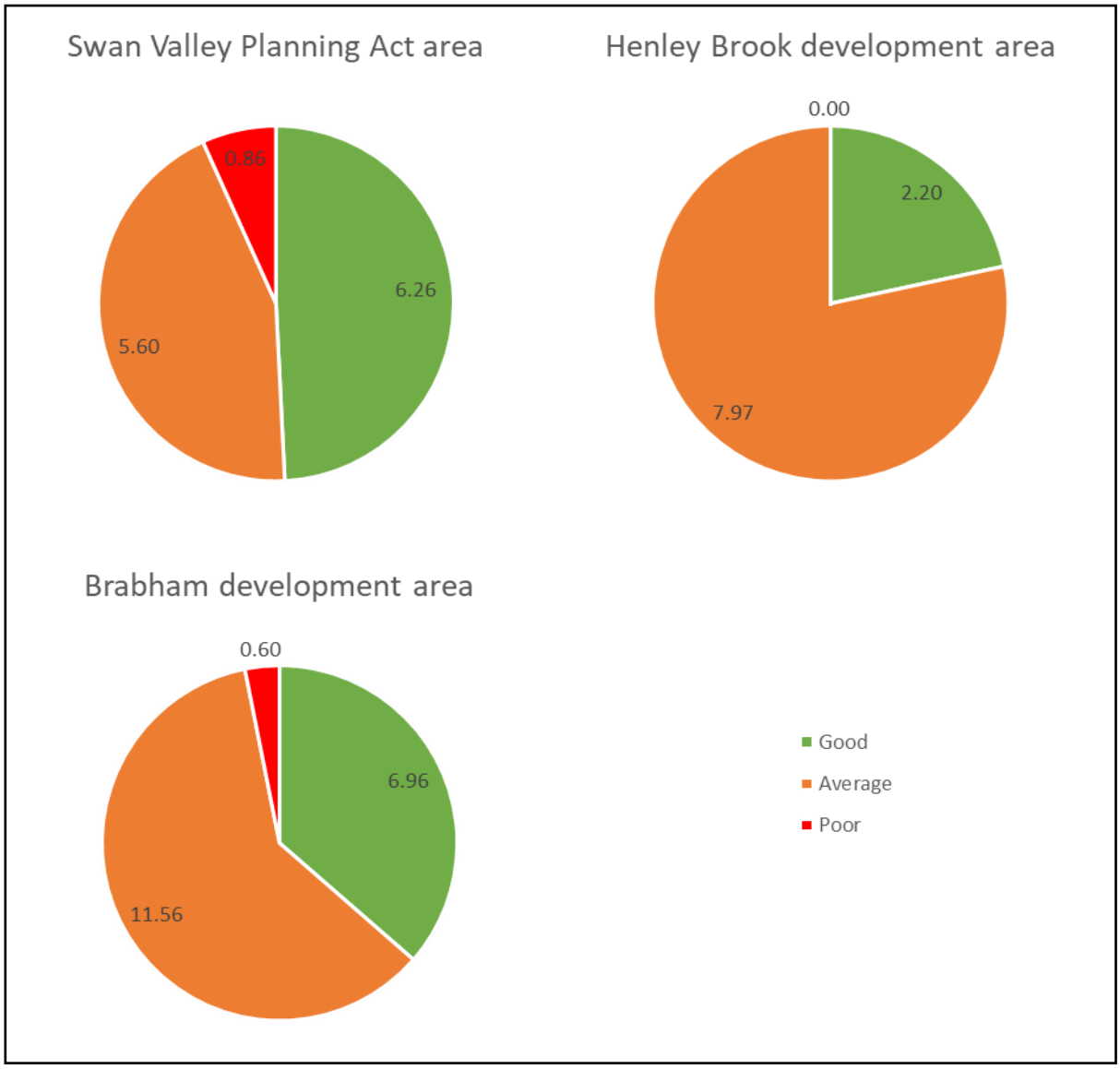


Figure 6: Bank stability in each assessment zone by length of streambank (km).

***Swan Valley Planning Act* area**

The creek system is made up of several channels in this zone. Moving upstream from the confluence with the Swan River, the creek is a single channel with steep to medium banks more than 1m high, until the junction of segments 14 and 71 (Figures 7 and 11). At this point a channel flows in from Brabham. It has been piped by the landholder at the outlet.

The channel from Brabham has been modified into a series of ditches. Localised flooding of roads is an issue for the local government during wet months. At the time of assessment the City of Swan was grading and deepening some of the ditches to alleviate flooding (Figure 8). Unfortunately, the process of grading also damaged some of the native overstorey of *Melaleuca pressiana*.

DoC plans to develop a wetland on the south east corner of Murray Road and Woollcott Avenue near segments 73-77 which would act as a compensation basin for drainage from new residential estates planned on the west side of Murray Road.


Figure 7 and 8: A channel flows in from Brabham at segment 14 and has been piped by the landholder to form a small waterbody (left); Banks have been graded in an attempt to reduce localised flooding (right).

Another channel flows in from the west at the junction of segments 15 and 53, where a dam has been created partly on private property and partly on City of Swan easement.

Upstream of the two junctions, the creek has mostly gradually sloping banks less than 1m in height (Figures 11 and 12).

This zone had some areas of localised erosion. This included a steep area where horses have constant access to the creek and have exposed the soil resulting in some gully erosion and undercutting (Figure 9). On part of the easement in the suburb of Henley Brook, adjacent private property landholders have installed culverts on the creek, changing the flow and leading to erosion around the culverts (Figure 10). The concrete culverts have mostly broken away from the banks.


Figure 9 and 10: Gully erosion on the lower banks of Saint Leonards Creek (left); Erosion near broken culverts in Henley Brook (right).

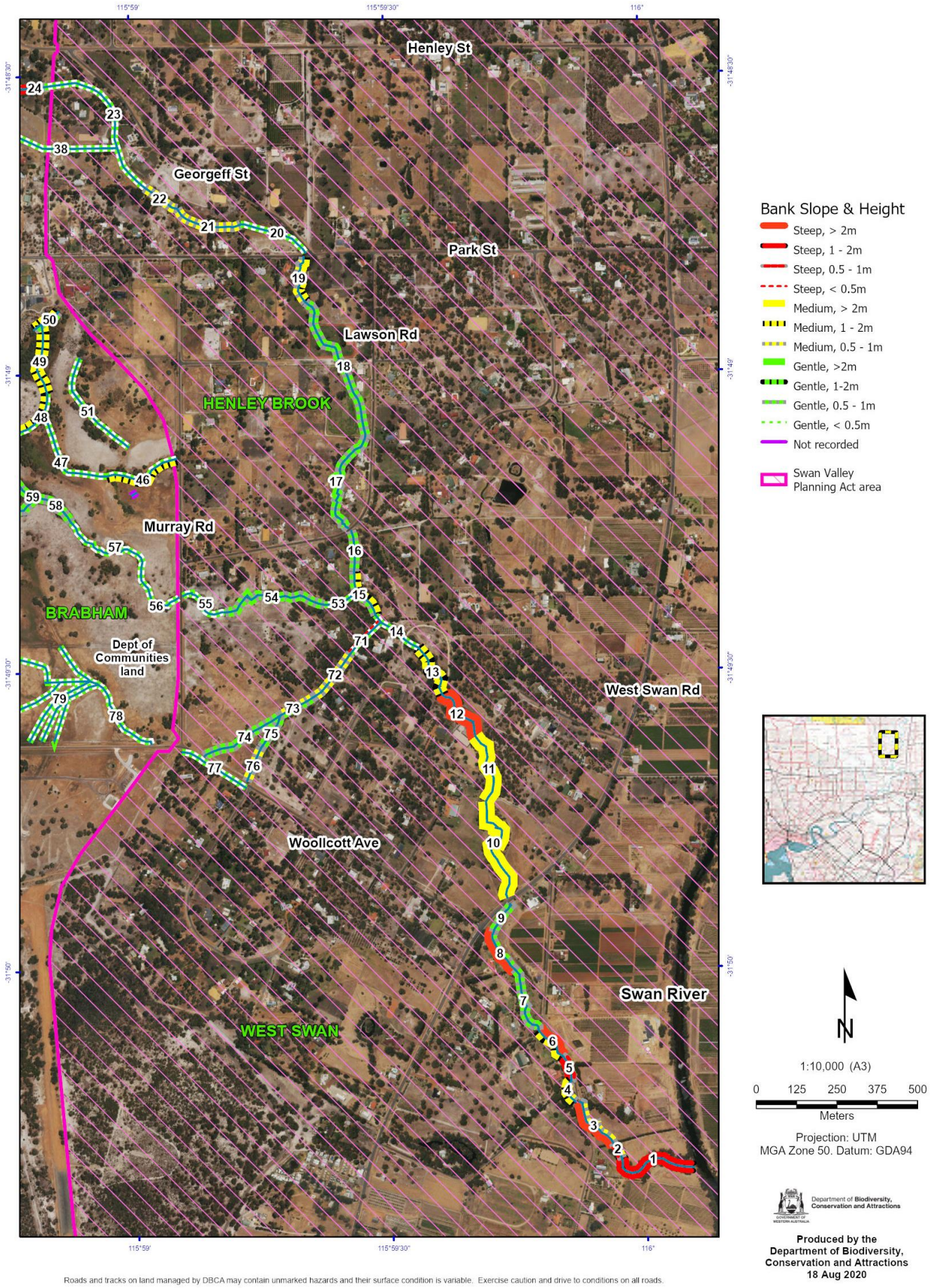


Figure 11: Bank slope and height in the Swan Valley Planning Act *area.*

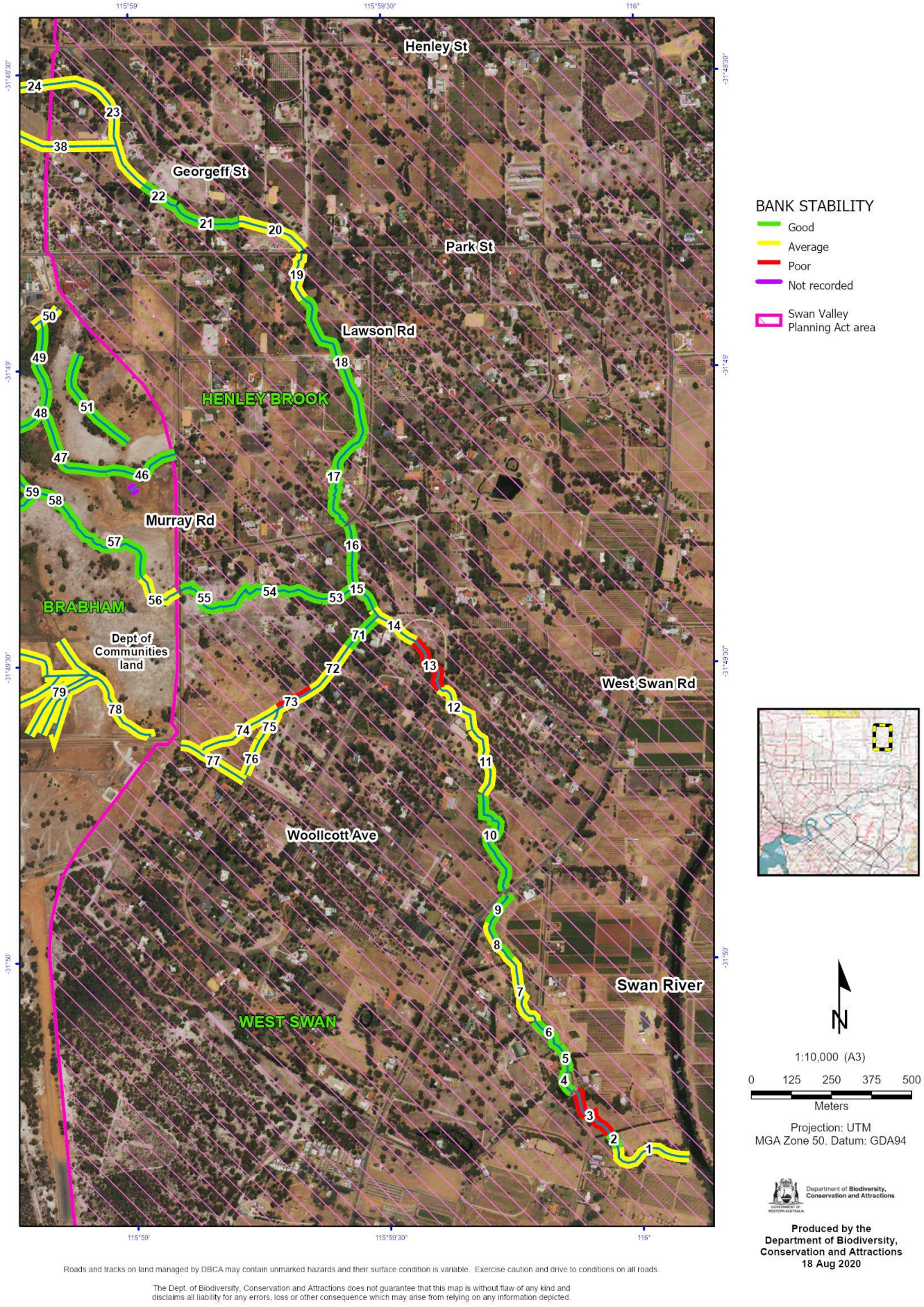


Figure 12: Bank stability in the Swan Valley Planning Act *area.*

Henley Brook development area

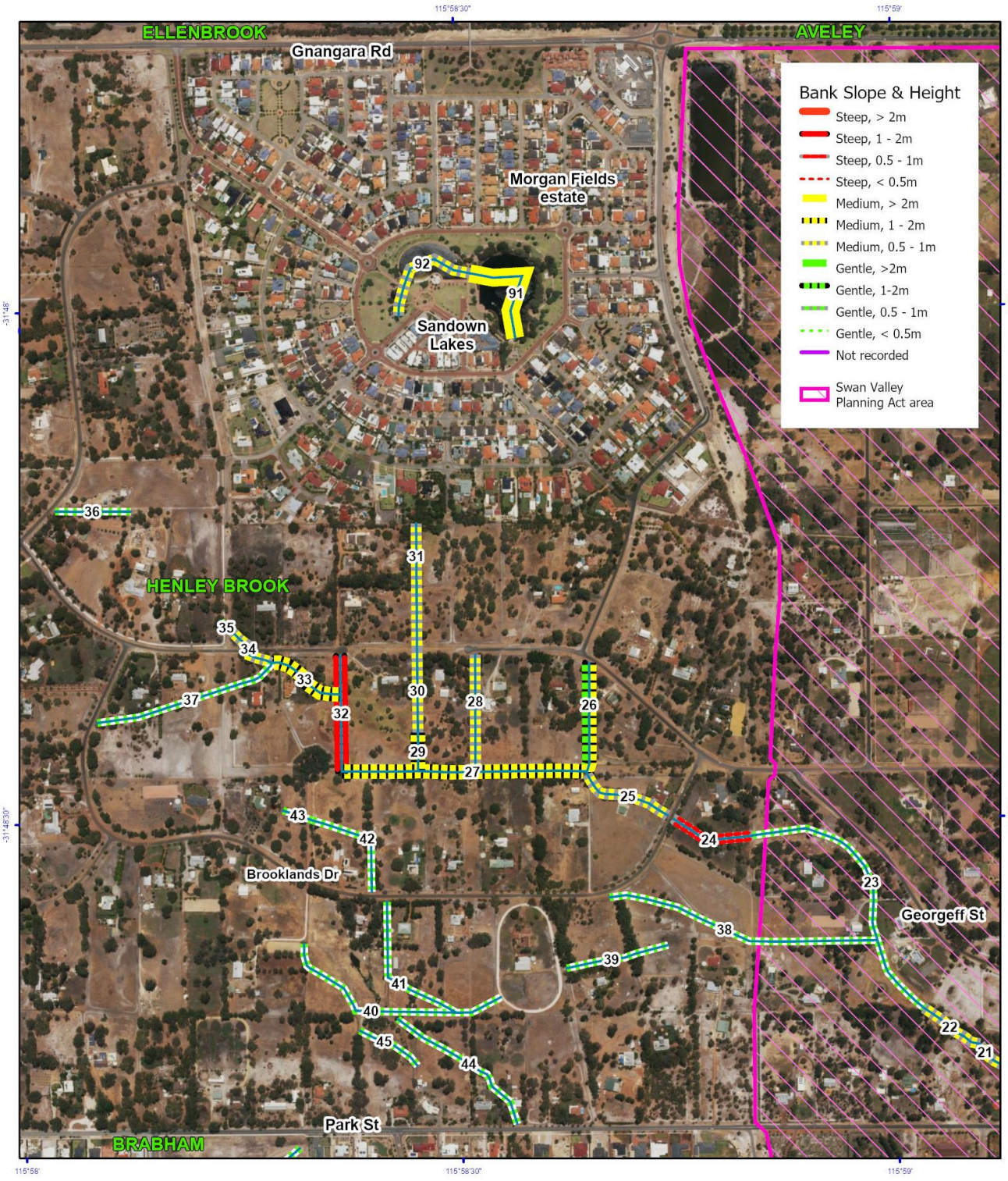
In this zone the creek system has been highly modified, mostly into straight ditches. The flat landscape is likely to have been palusplain wetlands that were cleared and modified to take local drainage when the land was developed into small hobby farms. Many landholders reported a lack of flow since the Morgan Fields residential estate was built in 2002. The creek alignment is almost impossible to follow on many hobby farms as much of it is a shallow depression only 0.1-0.2m deep with no riparian vegetation (Figures 13 and 14).


Figures 13 and 14: The creekline is a very shallow depression on many properties in Henley Brook (left and right).

Morgan Fields contains the headwaters of the north-south alignment of Saint Leonards Creek. Drainage from the estate is directed to the constructed Sandown Park lakes (Figures 15 and 16).

The upper lakes of Sandown Park are a series of three lakes lined with concrete and surrounded by hard footpaths. The lower lake is unlined and contains some native vegetation that is likely to have been planted.


Figure 15 and 16: Upper lake in Sandown Park, Henley Brook (left); Lower lake in Sandown Park (right).



1:6,500 (A3)

0 125 250 375 500

Meters

Projection: UTM
MGA Zone 50. Datum: GDA94

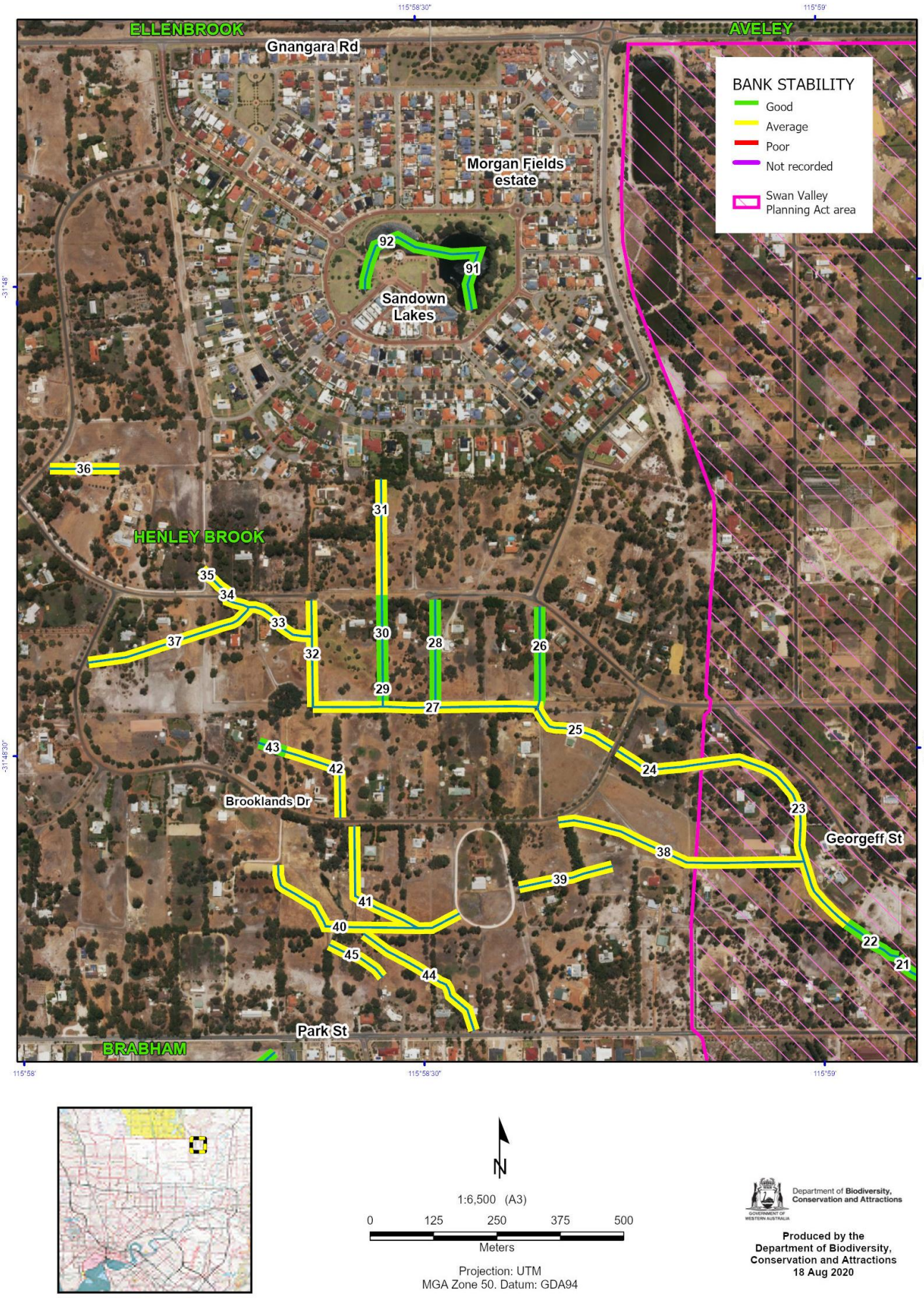
Department of Biodiversity, Conservation and Attractions

Produced by the Department of Biodiversity, Conservation and Attractions 18 Aug 2020

Roads and tracks on land managed by DBCA may contain unmarked hazards and their surface condition is variable. Exercise caution and drive to conditions on all roads.

The Dept. of Biodiversity, Conservation and Attractions does not guarantee that this map is without flaw of any kind and disclaims all liability for any errors, loss or other consequence which may arise from relying on any information depicted.

Figure 17: Bank slope and height in the Henley Brook development area.



Roads and tracks on land managed by DBCA may contain unmarked hazards and their surface condition is variable. Exercise caution and drive to conditions on all roads.

The Dept. of Biodiversity, Conservation and Attractions does not guarantee that this map is without flaw of any kind and disclaims all liability for any errors, loss or other consequence which may arise from relying on any information depicted.

Figure 18: Bank stability in the Henley Brook development area.

Brabham development area

The southern-most branch from Brabham flows across land owned by DoC. It has been realigned into a series of shallow, gradually sloping ditches (segments 78 and 79). The landform is flat, and the creek is likely to have been a palusplain of connected wetlands.

The other branch flowing in from Brabham also flows across DoC land (segments 56-63) but is not as highly modified. It incorporates a main channel and a series of palusplain wetlands (segments 46-51) including Pannage Wetlands (Resource Enhancement Wetland 8804) and several waterholes. These waterholes are likely to have been excavated when the area was farmed but have since become refuges for native flora and fauna (Figures 19 and 20). Two of these waterholes were monitored by North Metro TAFE.

Resource Enhancement Wetland (8805) Watervalley Boulevard Park has been disconnected to the creek through road networks and past landuse practices. The wetland is now within a residential estate and recreational infrastructure bisects the wetland. Drainage has also been placed in the wetland's buffer zone. This wetland was also monitored by North Metro TAFE.

Palusplain wetlands that are now mostly redeveloped into residential estates have been modified into constructed drainage channels or an underground pipe network and no longer connect with the creek system. Some of the open drainage is on public open space and has been revegetated with native plants. Dry compensation basins are also located in small parks in the housing estates (segments 88-90).

Figures 19 and 20: Waterholes in segment 56 (left) and segment 61 (right) on DoC land.

Bank stability is good to moderate across this zone, with areas of localised erosion along the Dampier-Bunbury pipeline alignment (segment 67) and adjacent to the Jungle Park in Whiteman Edge Estate (segment 85) where there is limited vegetation to contain the sandy banks.

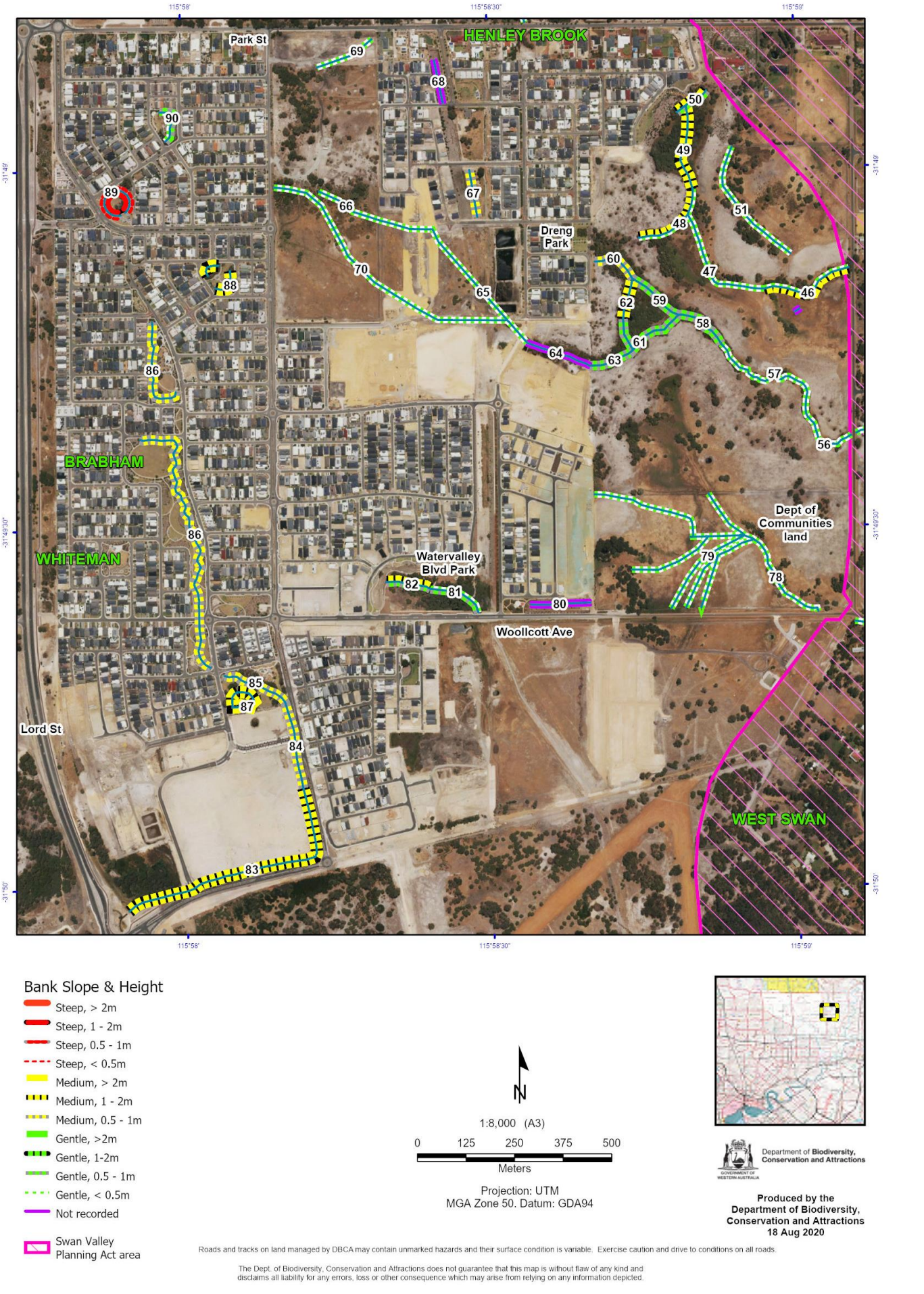
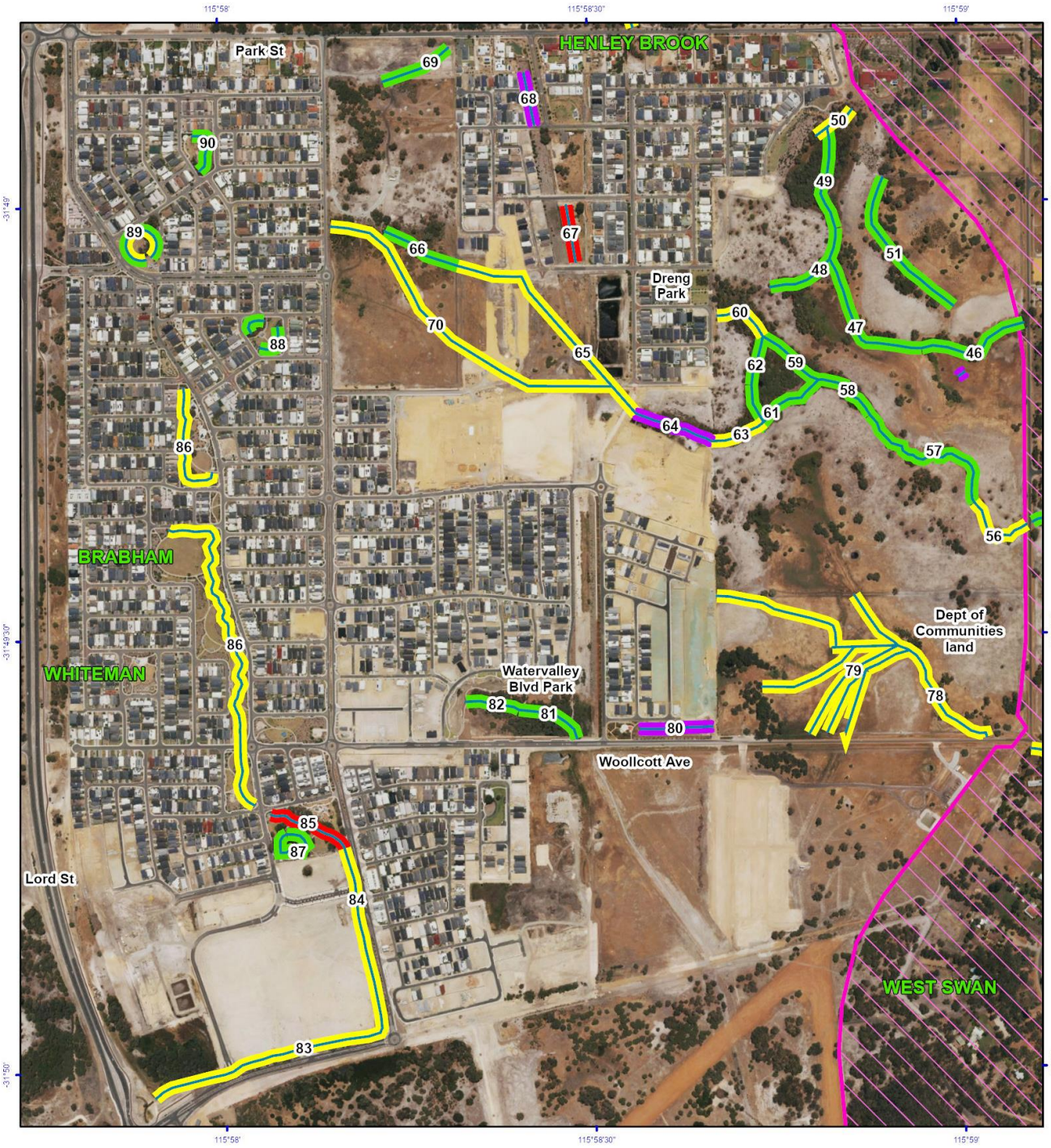


Figure 21: Bank slope and height in the Brabham development area.



BANK STABILITY

- Good
- Average
- Poor
- Not recorded

Swan Valley Planning Act area

N

1:8,000 (A3)

0 125 250 375 500

Meters

Projection: UTM
MGA Zone 50. Datum: GDA94

Department of Biodiversity, Conservation and Attractions

Produced by the Department of Biodiversity, Conservation and Attractions 18 Aug 2020

Roads and tracks on land managed by DBCA may contain unmarked hazards and their surface condition is variable. Exercise caution and drive to conditions on all roads.

Figure 22: Bank stability in the Brabham development area.

3.1.2 Vegetation types and condition

The original vegetation is Swan complex downstream of West Swan Road (woodland of *Eucalyptus rudis-Melaleuca rhaphiophylla*) and Southern River complex upstream of West Swan Road (open woodland of *Corymbia calophylla-Eucalyptus marginata-Banksia* species on the elevated areas and fringing woodland of *Eucalyptus rudis-Melaleuca rhaphiophylla* along streams).

Most of the riparian vegetation across Saint Leonards Creek is in poor condition. Much of the area has been cleared and farmed since early European colonisation and very few segments resemble pre-European remnant vegetation. The only areas of good condition vegetation are in the Brabham development area (Figure 23).

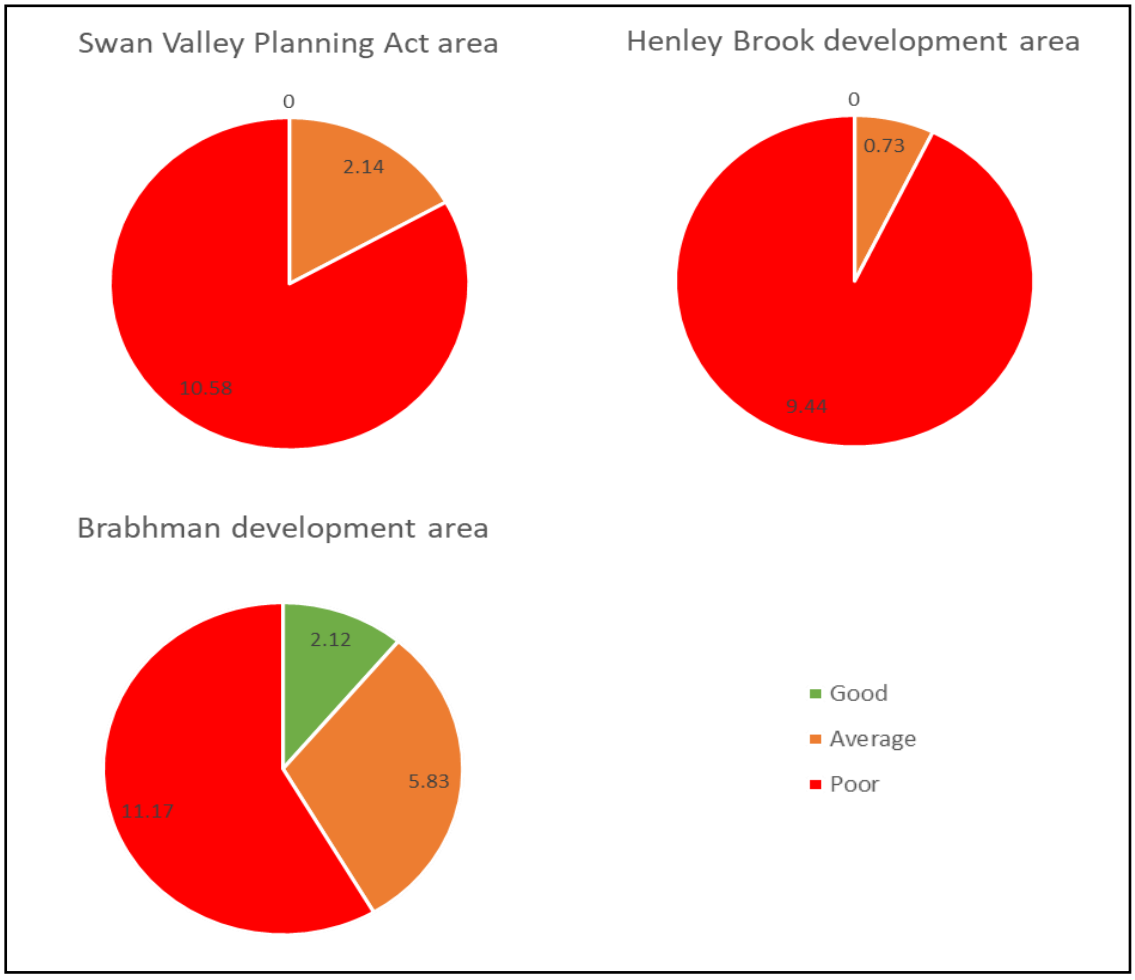


Figure 23: Vegetation condition in assessment zones by length of streambank (km).

Swan Valley Planning Act area

Vegetation type varies depending on the style of gardening and property maintenance of each landholder. Many landholders have added exotic species to remnant vegetation, such as Willows and other deciduous trees (Figure 24). There are many highly maintained and manicured gardens where lawns are mown regularly and native plants do not have a chance of recruitment (Figure 25).


Figures 24 and 25: Willow trees and other deciduous trees over grassy banks in West Swan (left); Mown lawn up to the banks of the creek, Henley Brook (right).

Many properties adjacent to the creek are small horse hobby farms, particularly along Lawson Road and Georgeff Street in Henley Brook. Where horses have access to the creek, the riparian understorey has been cleared and contains almost no native vegetation.

In contrast to most of the zone which has poor condition vegetation, two private properties contain average condition vegetation (Figure 28). South of West Swan Road, the landholders regularly control invasive weeds and have retained native upper and mid-storey vegetation (segment 8). South of Park Street in Henley Brook (segment 19), the landholder restricts horse access to part of their property and there is a diversity of native plants in the under- and mid-storey, including *Lepidosperma longitudinale*, *Kennedia prostrata* and *Astartea scoparia*.

On the City of Swan easement between West Swan Road and Lawson Road, the vegetation is remnant *Melaleuca rhaphiophylla* woodland with an understorey of weedy grasses and native shrubs. It is in average condition (Figure 26). Some well-established *Banksia* trees remain (Figure 27). Some revegetation has occurred with several species now not found elsewhere on Saint Leonards Creek: Mangles Kangaroo Paw (*Anigozanthos manglesii*), Harsh Hakea (*Hakea prostrata*), Prince of Wales Feather (*Ptilotus polystachys*) and Blueboy (*Stirlingia latifolia).*


Figure 26 and 27: Remnant woodland (left) and several well-established Banksia trees remain (right) on the City of Swan easement near West Swan Road.

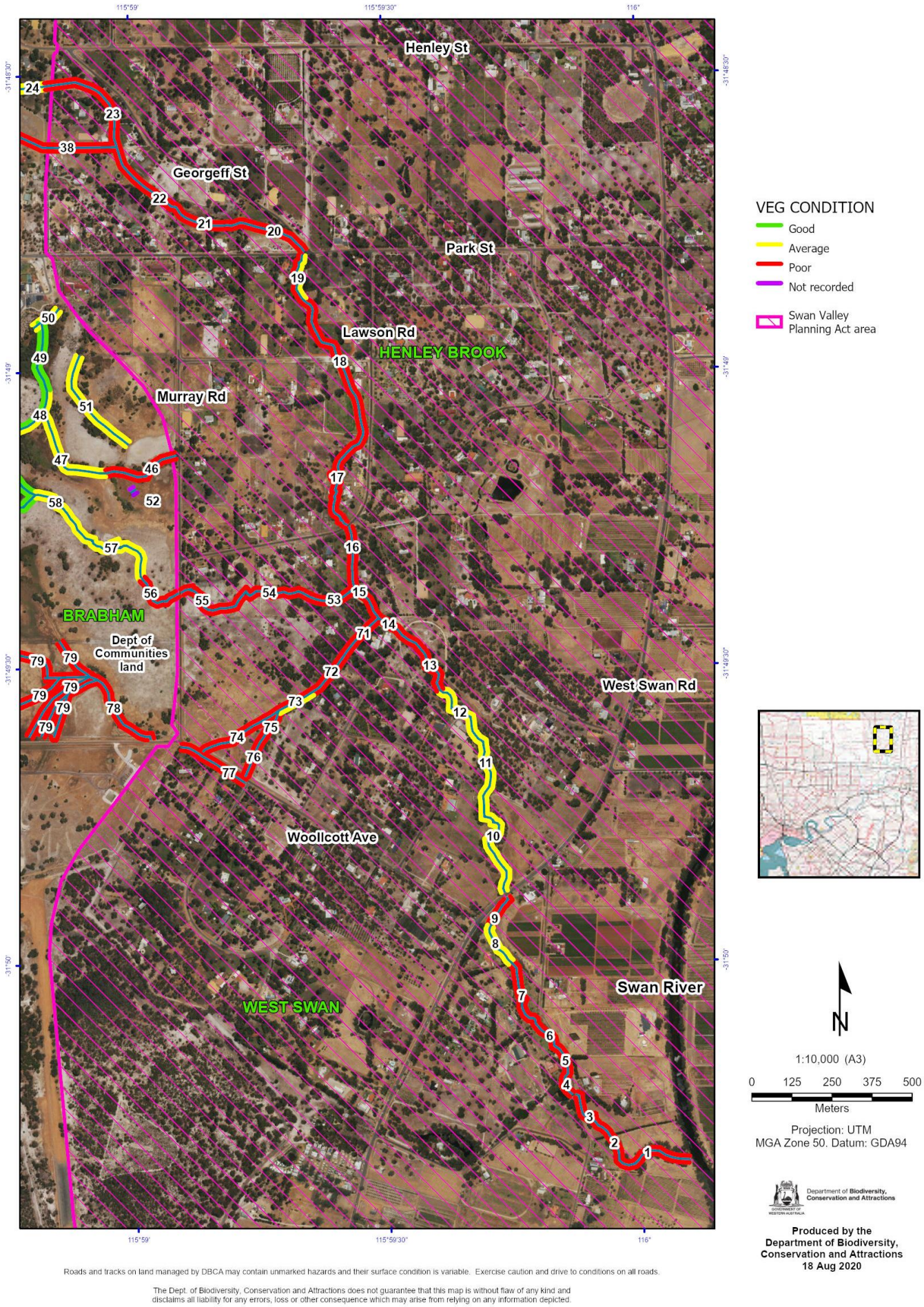


Figure 28: Vegetation condition within the Swan Valley Planning Act *area.*

Henley Brook development area

Riparian vegetation is almost absent, mostly through past clearing practices and modification of the creek into straight ditches. Very little water runs through the ditches, so wetland dependent vegetation cannot survive. Consequently, nearly all vegetation in this zone is in poor condition.

The overstorey is the most intact vegetation layer, but on many properties it is sparce to absent. Flooded gum (*Eucalyptus rudis)* and Eastern States Eucalyptus are the most common trees (Figure 29). If non-local Eucalypts are not outcompeting local natives, they should be retained to provide shade and habitat in new estates.

There are some small, isolated stands of sedges (Figure 30) but these are not common. The understorey is nearly all mixed weedy grasses and there is virtually no mid-storey present. Small dams are present on some properties, mostly planted with exotic garden species.


Figures 29 and 30: Established Eastern States Eucalyptus (left); Isolated stand of Juncus pallidus *in grassy paddock (right).*

Native riparian vegetation was only apparent immediately west of the *Swan Valley Planning Act* area (segment 24), and around the lower lake in Sandown Park (segment 92). Both segments were in average condition (Figure 33).

Segment 24 is near the corridor for the proposed Henley Brook Avenue and was the only segment in this zone where *Melaleuca viminea* was dominant (Figure 31). Sandown Park is parkland maintained by the City of Swan and comprised of three upper lakes (segment 92) and a lower lake (segment 91). Vegetation around the upper lakes is landscaped with exotic and non-local species. The lower lake is surrounded by a narrow strip of remnant *Melaleuca rhaphiophylla* and sedges (Figure 32). Local natives were mostly planted around the lower lake.


Figures 31 and 32: Remnant sedges and Melaleuca viminea in segment 24 (left); Native vegetation on the lower Sandown Park lake (right).

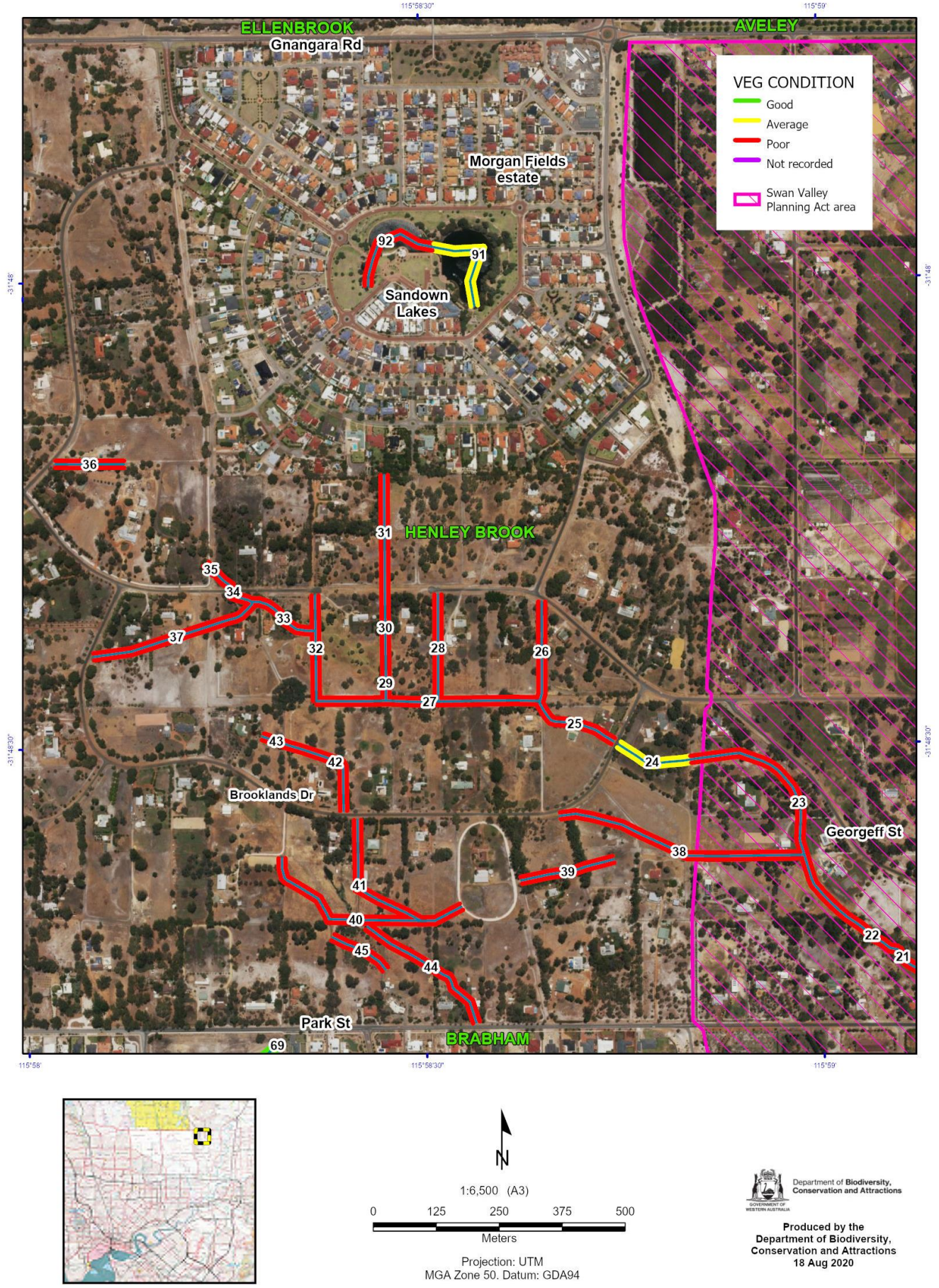


Figure 33: Vegetation condition in the Henley Brook development area.

Brabham development area

This is the only zone where good condition vegetation was found. However, it is located on land proposed for residential development or has been cleared since the assessment (e.g. segment 69, Figure 37). Remnant vegetation has been impacted by past land practices but in areas has regenerated and is in good condition. No good condition vegetation was found where urban development has taken place.

In Whiteman Edge Estate the creek has been modified into drainage channels (e.g. segment 86, Figure 34) or piped. Native plants have been used in the landscaping. The overstorey has not yet established but over time will provide shade and habitat.

Some small parks in Whiteman Edge are dry compensation basins that have been revegetated with native plants. Most of these are in average condition and will need ongoing maintenance as they are vulnerable to weed incursion and rubbish. Savello Park (segment 89; Figure 35) was in poor condition as a limestone wall prevents a transition to the remnant Marri woodland and weeds are establishing.


Figure 34 and 35: Native vegetation planted in drainage channels in Whiteman Edge Estate (segment 86) (left); Savello Park in Whiteman Edge Estate (right).

On DoC land, Pannage Wetlands (Resource Enhancement Wetland 8804, segments 49, 50), connecting vegetation (segments 46-48), and the channel (segments 56-63) are mostly in good to average condition (Figure 38).

In particular, segments 48, 49, 59 and 61 have high diversity with dominant genera including *Corymbia, Astartea, Lepidosperma* and *Baumea* (Figure 36). Given the overall degraded nature of Saint Leonards Creek, this vegetation is highly valuable and should be protected. Remnant stands of *Xanthorrhoea brunonis* also occur on DoC land. With revegetation and weed and access control, areas in average condition will regenerate and can be restored to good condition.


Figures 36 and 37: Baumea articulata *sedgeland on DoC land (left), and diverse sedgeland on a proposed estate which is now cleared (right).*

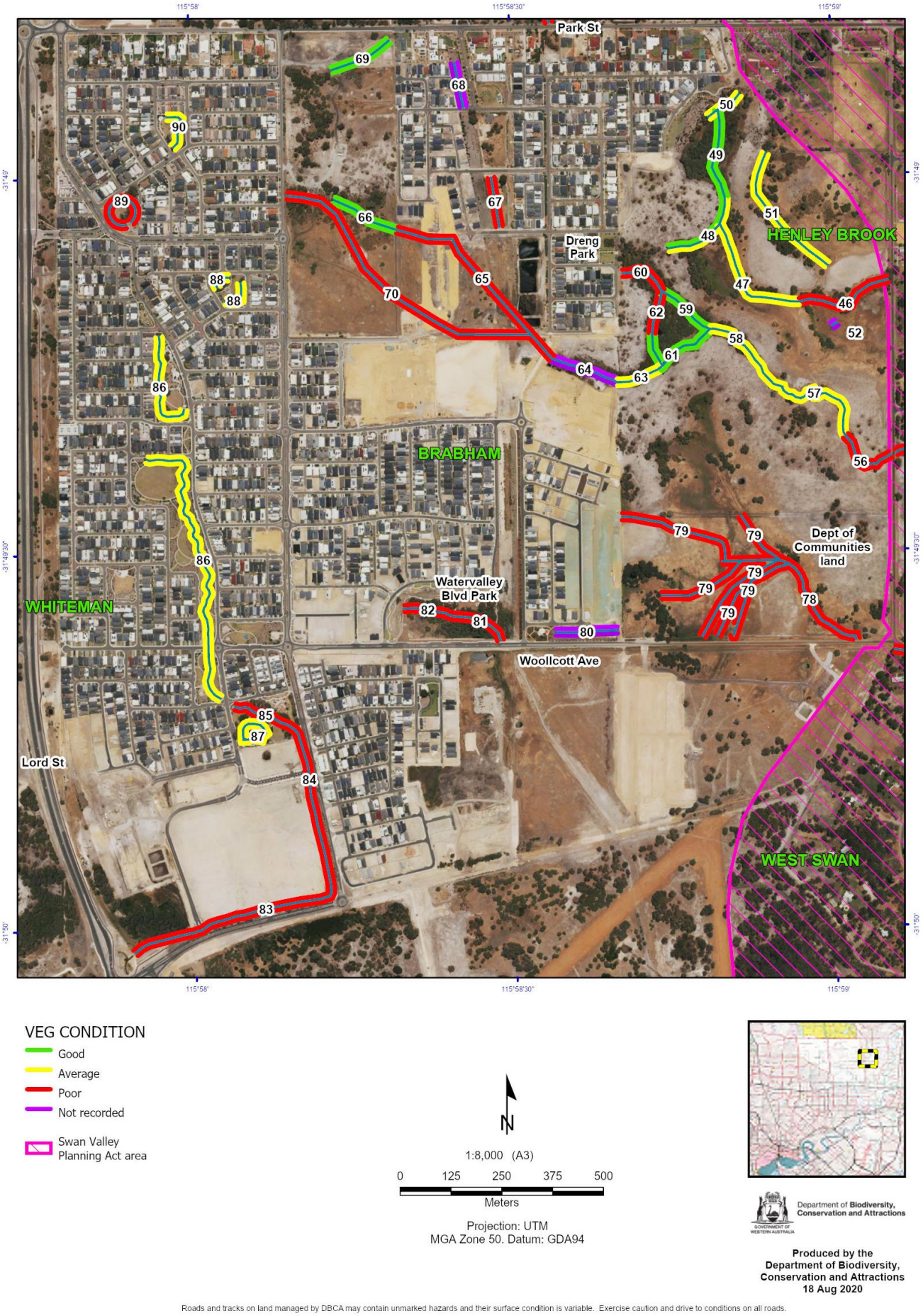


Figure 38: Vegetation condition in the Brabham development area.

3.1.3 Weed cover and species

Most of the riparian vegetation had moderate to extensive weed cover (Figure 39). No areas of minimal weed cover were found in the *Swan Valley Planning Act* area and less than 0.5km of streambank in the Henley Brook development area had minimal weed cover. The Brabham development area was the only zone that had significant areas of minimal and moderate weed cover.

Refer to Appendix 1 for weed control recommendations for each segment.

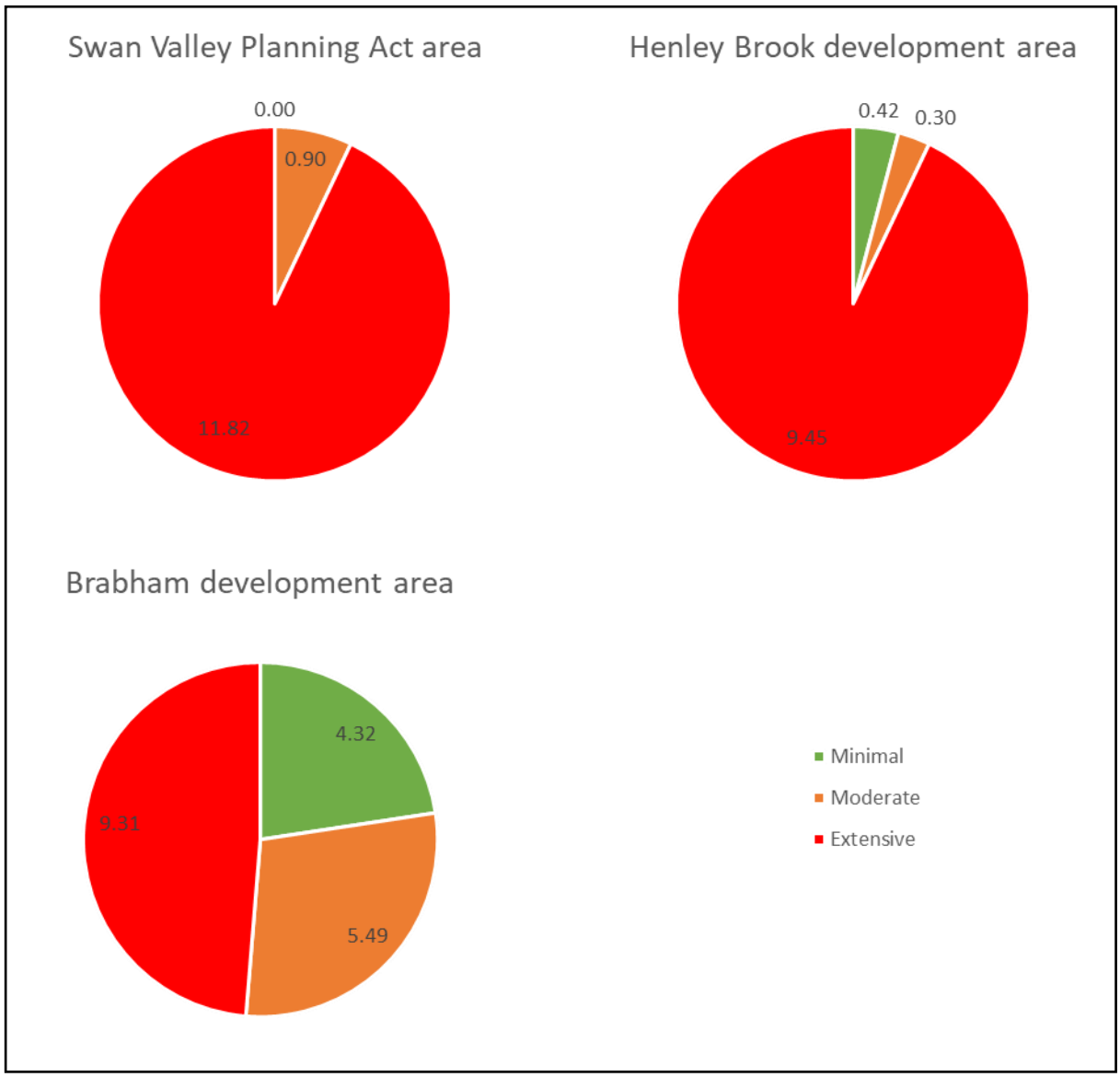


Figure 39: Weed cover in each assessment zone by length of streambank (km).

Swan Valley Planning Act area

Most of this zone had extensive weed cover (Figure 44). Kikuyu grass is dominant throughout the whole zone and it makes up the bulk of the understorey in many segments. Most of the zone has been farmed since European settlement and much of it is now grazed by horses. *Watsonia* was common south of West Swan Road (Figure 40) and Arum lily was common south of Lawson Road (Figure 41). Other widespread understorey species throughout this zone were Dock (*Rumex* sp.), *Persicaria*, Trefoil (*Lotus sp.*) and Ryegrass (*Lolium sp.*).


Figures 40 and 41: Watsonia *(left) and Arum Lily (right) are common on the lower reaches of Saint Leonards Creek.*

Isolepis prolifera was also found in nearly every segment north of Lawson Road and is a high concern because it has the potential to spread rapidly. Once established, it is very difficult to remove. It is a priority for removal before it establishes in the lower reaches.

In the upperstorey, exotic trees and Figs have partly replaced the native flooded gum and swamp paperbark woodland (Figure 42). Dense infestations of Brazilian Pepper were found south of Park Street and near the City of Swan easement south of Lawson Road (Figure 43). The Brazilian Pepper trees at Park Street have now been removed by the landholder with funding from DBCA.


Figures 42 and 43: Extensive weed cover of Juncus microcephalus*, Trefoil and* Isolepis prolifera *(left); Dense infestation of Brazilian Pepper over Kikuyu (right).*

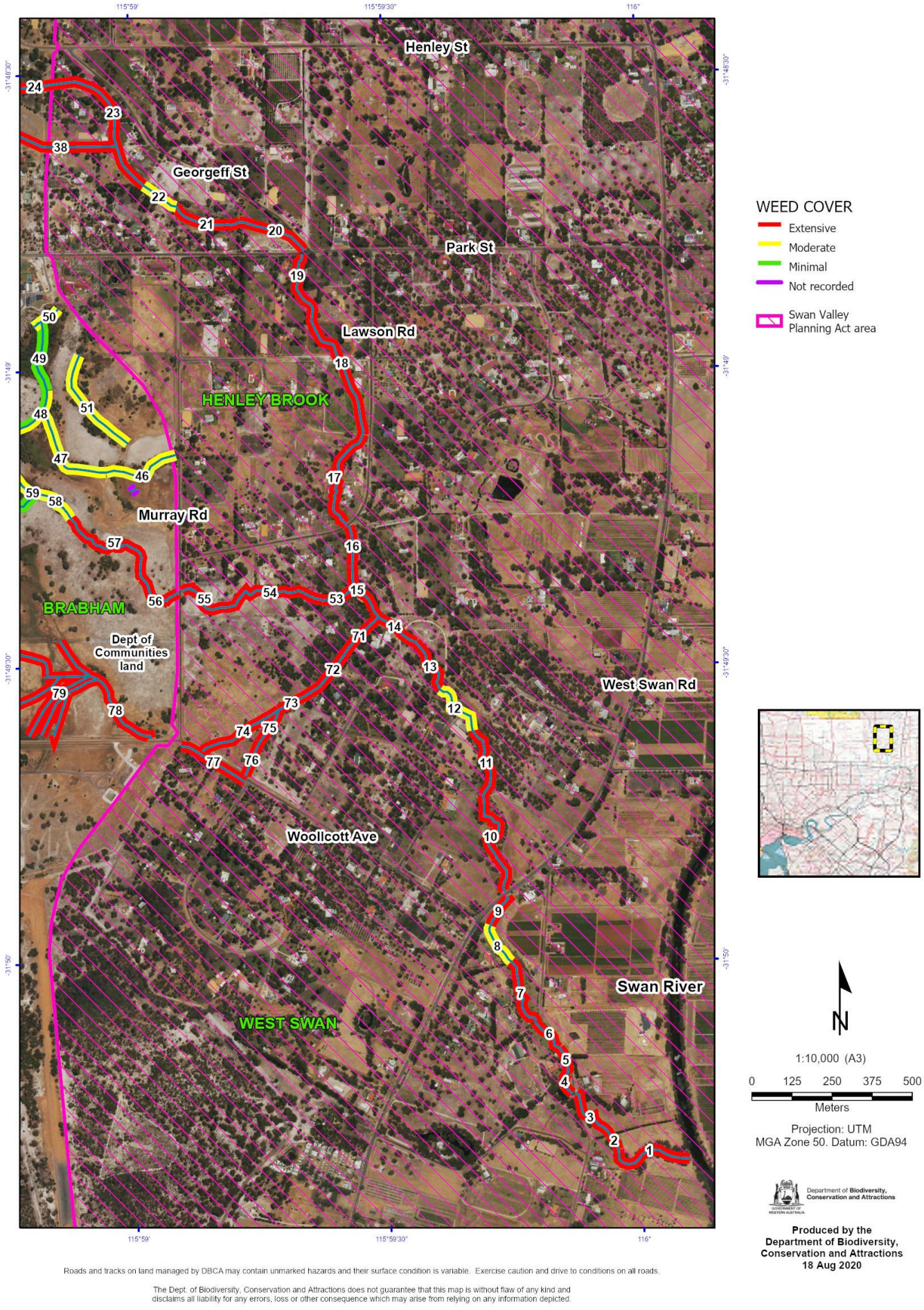


Figure 44: Weed cover in the Swan Valley Planning Act *area.*

Henley Brook development area

Most of this zone had extensive weed cover (Figure 49). Similar to the *Swan Valley Planning Act* area, the zone has been farmed and weedy grasses are common in the understorey. The most widespread weedy grasses are Kikuyu, Couch and Perennial Veldt Grass (Figure 45). Very few native plants remain in the under- and mid-storey.


Figure 45 and 46: Kikuyu and other weedy grasses are common and widespread (left); Flooded gum and weedy Eastern States Acacias in Segment 30 (right).

Where trees are present, Eastern States Eucalyptus are common. Many of these are well established and contain hollows for arboreal fauna.

Only two segments did not have extensive weed cover:

- A shallow drainage channel, which has native mid-storey species and a dense population of Marri trees mixed with weedy Eastern States Acacias (segment 30, Figure 46); and
- The lower lake in Sandown Park, which is regularly maintained by the City of Swan and has concrete kerbing in place to delineate lawn from the native vegetation surrounding the lake (segment 91, Figure 47).

The upper lakes of Sandown Park have been planted with exotic landscaping species that have the potential to become weedy if not monitored and contained, including Fountain Grass (Figure 48) and Lantana.


Figures 47 and 48: Concrete kerbing delineates mowed grasses at the lower Sandown Park lake (left); Planted Fountain Grass in the upper lake (right).

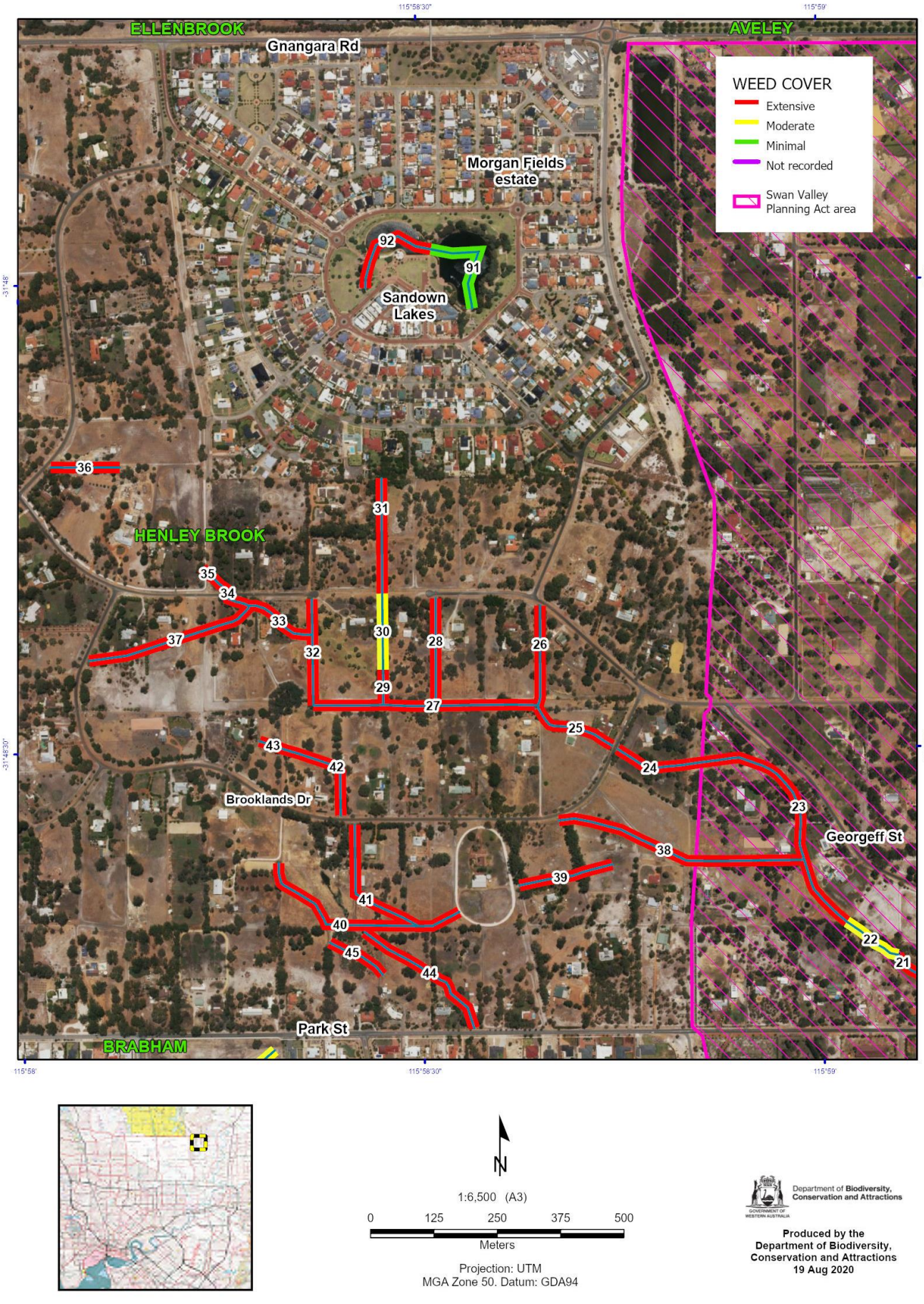


Figure 49: Weed cover in the Henley Brook development area.

Brabham development area

On DoC land, many segments near Resource Enhancement Wetland 8804 and the triangular piece of vegetation (segments 59, 61 and 62) have minimal to moderate weed cover and are of high conservation value. Where the riparian buffer is very narrow (segments 56 and 57), the weed coverage is extensive due to historical clearing and opportunistic invasion of weeds (Figure 52).

The drain outlet from Dreng Park is a major source of weeds (*Isolepis prolifera*, Spear thistle, various grasses) to downstream high value areas and is a priority for management (Figure 50). A dense infestation of *Isolepis prolifera* immediately upstream of the triangular piece of vegetation should also be controlled urgently (Figure 51). In the south of the DoC land, the understorey is entirely comprised of weedy grasses and herbs such as Cotton Bush. The focus should be on preventing the existing weeds from being further disbursed, particularly during the construction phase of development.

Figures 50 and 51: A drain outlet from Dreng Park is a significant source of weeds including Spear Thistle (left) and Isolepis prolifera *(right).*

A number of weeds in or surrounding Watervalley Boulevard Park are proposed for control as part of the adjacent residential development. This should be monitored to ensure control has been effective.

In the revegetated drainage channels in Whiteman Edge, weed cover is mostly minimal as weeds are actively managed. However, in Savello Park (segment 89) weedy grasses and herbs are starting to outcompete natives and should be controlled.

Segments 83 and 84 in Whiteman Edge Estate were under development and contained almost no native vegetation. Most segments in the proposed Ariella Estate had extensive weed cover due to historic clearing and farming. Several invasive weeds were found, including Castor Oil, Cottonbush and Inkweed. Segments 66 and 69 had diverse remnant vegetation and generally only had weeds growing on the edges. However, segment 69 has since been cleared for housing (see cover photos of report).

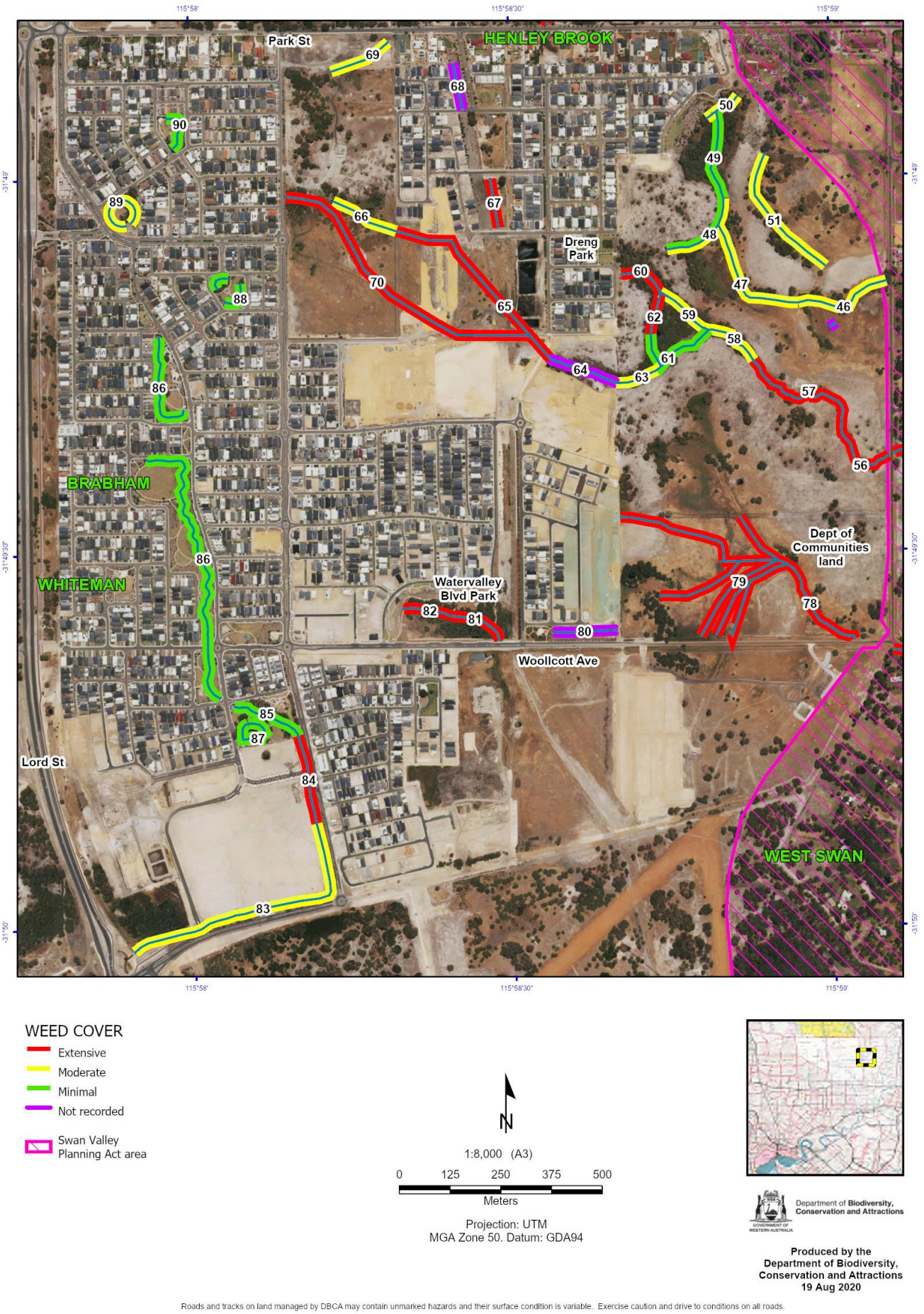


Figure 52: Weed cover in the Brabham development area.

3.1.4 Status of *Typha sp.* in Western Australia

Two species of *Typha* occur in south-western WA – *Typha domingensis* and *T. orientalis,* which until recently was considered a naturalised weed. Evidence suggests that *T. orientalis* occurred naturally prior to European settlement (Keighery and McCabe 2015) and the species is now listed as native to WA. The two species are known to hybridise and can be difficult to distinguish. *T. orientalis* in particular can be prolific on the shallow edges of waterways and impede water flow and outcompete other native vegetation.

T. orientalis was removed through many restoration projects in south-west WA prior to being listed as native. Clearing permits are now required through DWER. Where it acts as an environmental weed on public land, a clearing permit may be exempt if removal of *Typha* is part of an approved management plan or maintains existing cleared areas around infrastructure. On private land, however, landowners may need to apply for a clearing permit. Permit advice should be obtained from DWER.

In this assessment, recommendations were made to monitor and manage *Typha* where it appeared to be impacting high value native vegetation (Appendix 1). Management of *Typha* may involve ensuring the population does not become larger than its current extent, planting other robust native plants adjacent to it, or partially removing and replacing *Typha* with suitable native species.

3.1.5 Pen and Scott rating

It is important to note that the Pen and Scott grading was originally designed for farming and rural areas, so the information relating to grazing and stock access was not relevant for the developed areas of Brabham. The C grades are for erosion prone banks where vegetation has been cleared by stock and not relevant to all segments on Saint Leonards Creek. A segment may have otherwise been in poor condition and subject to other pressures (such as runoff from adjacent residential development) that were not listed in this grading system.

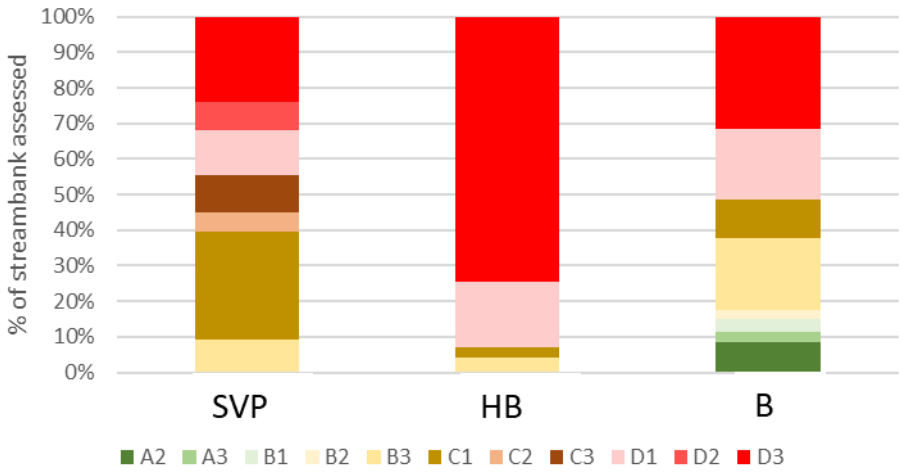


Figure 53: Pen and Scott rating for each assessment zone. Data are shown as a percentage of segment length for each zone.

The *Swan Valley Planning Act* area and Henley Brook development area zones had no segments in the A grades (pristine to slightly disturbed). In the Brabham development area, 2.2km of streambank were rated A2 or A3 (slightly disturbed). No segments were considered A1 (pristine) (Figures 53 and 56).

The Brabham development area was also the only zone to have segments rated B1 (degraded – weed infested) and B2 (degraded – heavily weed infested). This highlights the need to protect existing remnant vegetation in the Brabham area given the overall condition of Saint Leonards Creek.

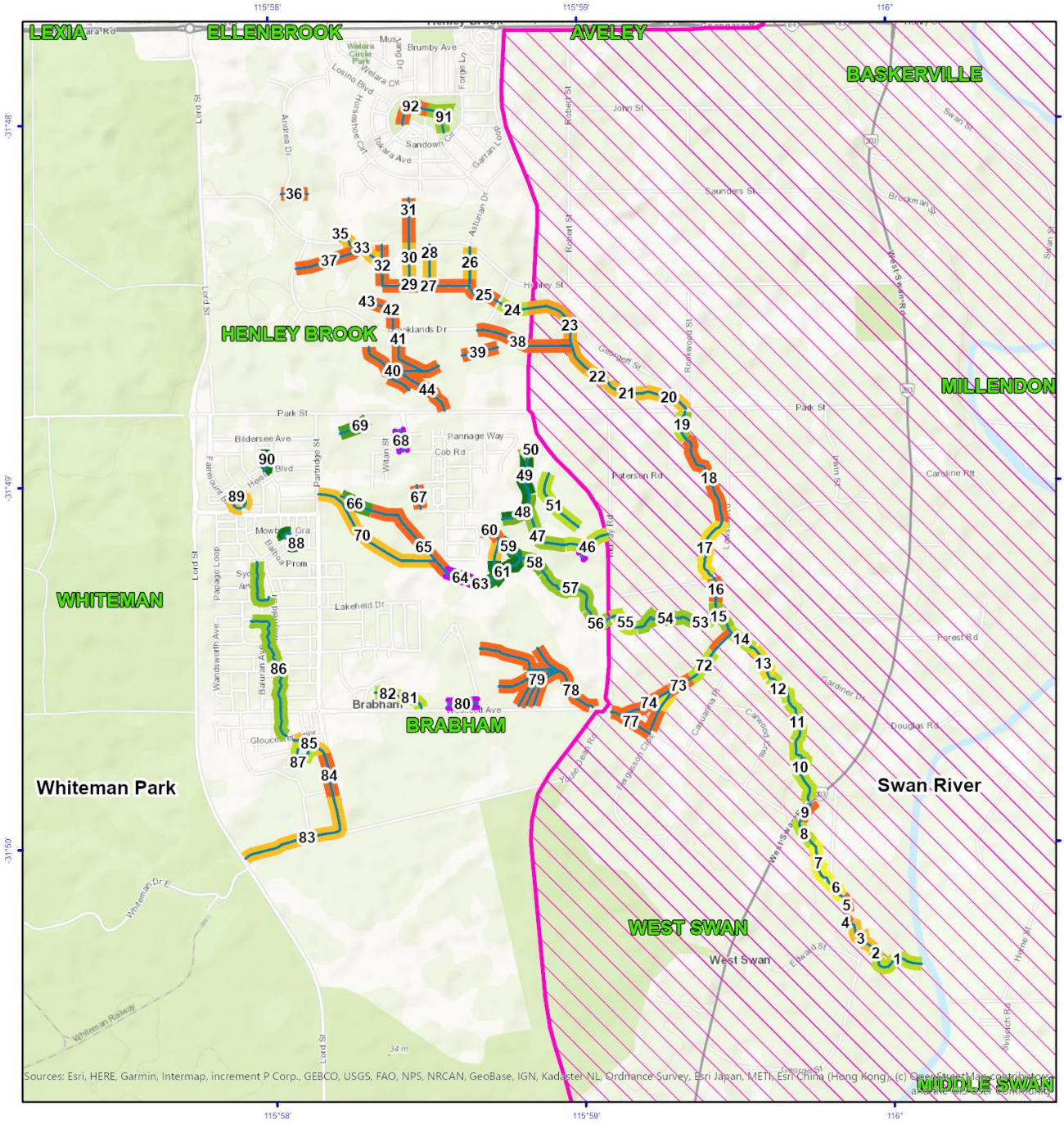
The highest rating of segments in the *Swan Valley Planning Act* area and Henley Brook development area was B3 (degraded – weed dominated) with 1.2km and 0.4km of streambank respectively. In contrast, nearly 4km of the Brabham development area was rated B3.

Nearly equal lengths of streambank were rated C or D grades in the *Swan Valley Planning Act* area. C1 (erosion prone) and D3 (drain-weed dominated) were the most common ratings, with 3.9km and 3km of streambank respectively.

In the Henley Brook development area, only 0.3km of streambank was rated C1, and none was rated C2 (soil exposed) or C3 (eroded) as there is such limited flow that erosion is not an issue in this zone. 1.9km of streambank was rated D1 (ditch - eroding) and 7.6km was rated D3. This is due to the modification of the creek system into ditches, most of which are heavily weed infested and receive little water flow.

Although there were areas of high condition in the Brabham development area, there were still significant stretches of streambank rated C1 (2km), D1 (3.9km) and D3 (6km). Most of the streambank rated D3 was located on the south of the DoC land (segments 78 and 79) (Figure 55).

Figure 54 and 55: Segment 61, rated A2, near pristine (left); Segment 78, rated as D3, a weed dominated drain (right). Both segments are located in the Brabham development area.



Pen & Scott rating

- A2
- A3
- B1
- B2
- B3
- C1
- C2
- C3
- D1
- D2
- D3
- Not recorded

Swan Valley Planning Act area

1:20,000 (A3)

0 250 500 750 1,000

Meters

Projection: UTM
MGA Zone 50. Datum: GDA94

Department of Biodiversity, Conservation and Attractions

Produced by the Department of Biodiversity, Conservation and Attractions 18 Aug 2020

Roads and tracks on land managed by DBCA may contain unmarked hazards and their surface condition is variable. Exercise caution and drive to conditions on all roads.

The Department of Biodiversity, Conservation and Attractions does not guarantee that this map is without flaw of any kind and disclaims all liability for any errors, loss or other consequence which may arise from relying on any information depicted.

Figure 56: Pen and Scott rating across Saint Leonards Creek.

3.2 Landholder consultation

Landholder anecdotes of the creek, including changes in its condition and wildlife observations, were recorded during the assessment. A summary is provided below; for detailed landholder observations see Appendix 2.

Many landholders were interested in the creek and wanted to protect the wildlife that visits their properties but were unaware which plants were weeds or natives, or what a natural creek ecosystem would look like. Providing further information and education is critical to engaging landholders to actively manage and protect the creek. There is an opportunity for the City of Swan to provide some of this information to new landholders when properties are sold.

Some landholders are already making efforts to protect the creek and encourage native animals on their properties. As an outcome of this assessment, six landholders are working with DBCA and the City of Swan to conduct weed control and revegetation on their properties. One landholder has also erected fencing to exclude horses from the creek.

3.2.1 *Swan Valley Planning Act* area

Letters were sent to the 36 landholders in this zone asking to access their property to conduct the assessment. The letters were followed up with phone calls. Of the 24 landholders we could speak directly with, through phone calls or meeting on site, 16 provided observations about the creek over the time they had lived on their properties.

The most common concerns were a decline in wildlife populations (Figure 57), and the impact on wildlife from reduced water flow in the creek, foxes or speeding boats (only near the Swan River). Species they had noted declining over a 20-30 year time period were turtles and freshwater crayfish (such as Gilgies or Koonacs).

Many landholders were also concerned about sediment blocking pipes and sludge occasionally flowing down the creek. This included in West Swan near the confluence with the Swan River (two reports), and in Henley Brook along Lawson Road and Park Street (two reports) and Georgeff Street (one report). Many landholders associated the sludge with the construction of nearby residential estates or according to one landholder when wastewater was pumped from an upstream estate. Another landholder along Lawson Road was concerned about the bad smell of the creek water.

3.2.2 Henley Brook development area

Letters were sent to 30 landholders in this zone. Developers have bought properties in this area but have given landholders several years to move out, so we were still able to make contact with many of them.

Of the 11 landholders we could speak with or meet, seven raised concerns about the condition of the creek.

Six landholders were concerned about the lack of water in the creek (Figure 57). One resident had lived on the property for about ten years and did not realise there was a creek.

Throughout this zone, most of the creek has been modified and straightened into a series of ditches. One landholder said he rang the City of Swan sometime previously about Saint Leonards Creek and was told it was a drain, not a creek.

Many landholders had been on their properties for about 30 years and nearly all of them mentioned that the lack of flow had occurred since the residential estate Morgan Fields was established. Several residents said it had not been a creek since then.

According to another landholder, a natural spring along Henley Street had been over pumped by a state agency and growing near the spring was a pine plantation that had consequently died.

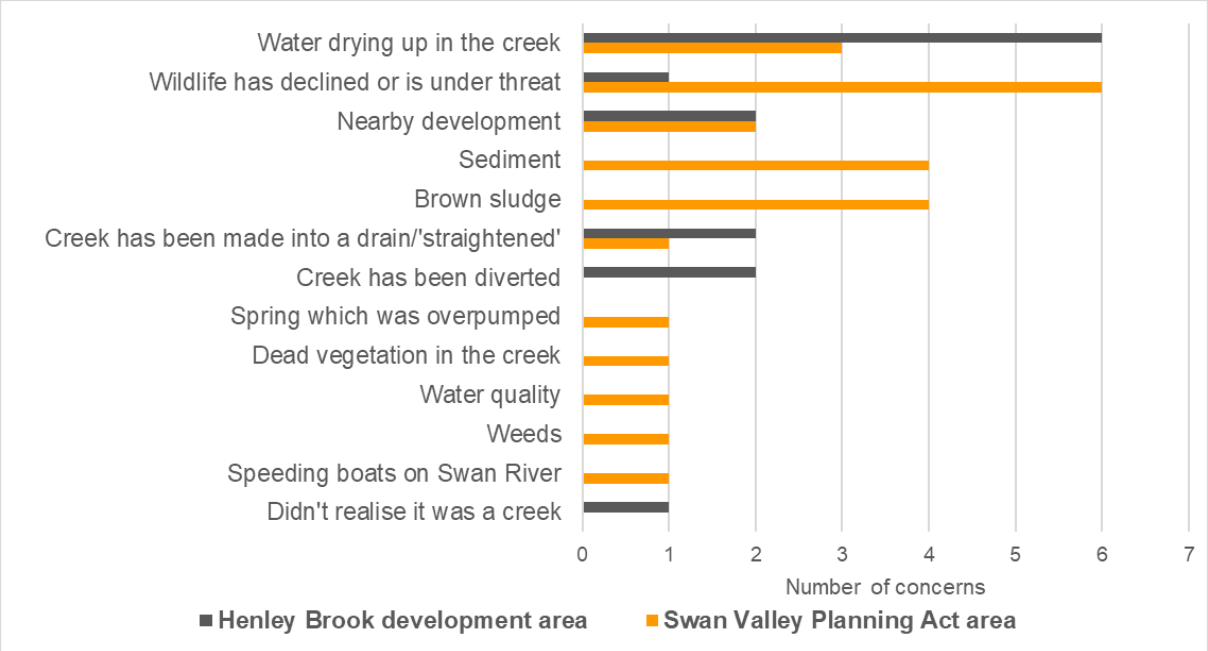


Figure 57: Concerns raised by landholders prior to or during the assessment from the Swan Valley Planning Act and Henley Brook development areas. Landholders may have raised more than one concern.

3.2.3 Brabham development area

Letters were not sent to landholders in this area. Properties owned or leased by residents are high density dwellings and Saint Leonards Creek has been modified into drainage channels or compensation basins in public open space.

Phone contact was made with two companies who were listed as owning large properties in Brabham for permission to access. One company said that it was not an appropriate time to access and so the assessment was made from surrounding roads; and the other had no objection with the property being accessed to conduct the survey. Neither company raised any concerns about the condition of the creek.

3.3 Water monitoring

The water quality monitoring conducted by North Metro TAFE students is a snapshot from February to May 2019, undertaken as a learning process with the analysis completed at the TAFE laboratory. Although the correct protocols were adhered to, these results can only be considered as indicative and further monitoring would be required to validate the results.

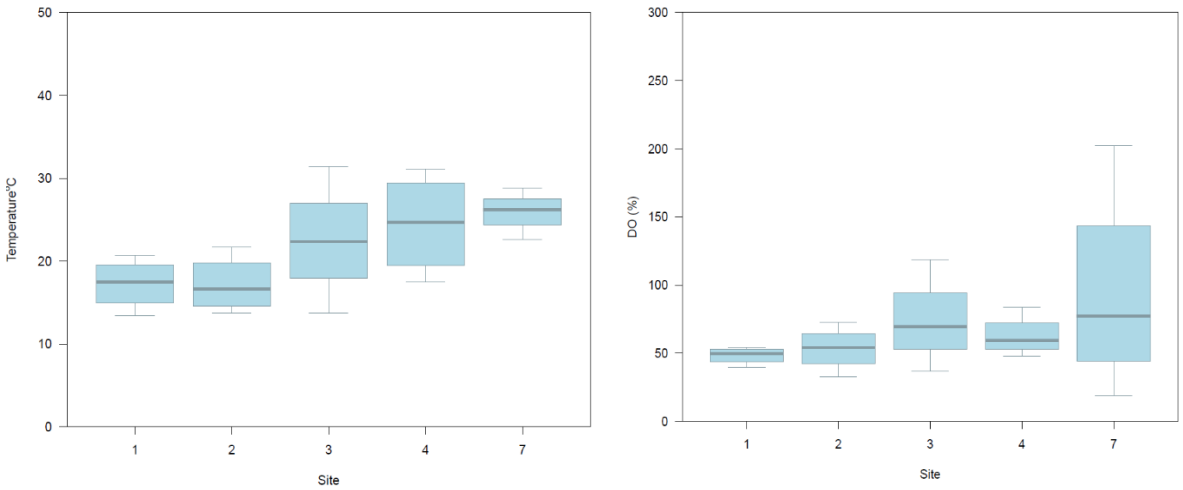
3.3.1 Surface water quality

Only five of the eight sites were surveyed due to lack of water during the sample period from February to May 2019. The observations in Table 3 were made by North Metro TAFE lecturer G. Dolva and student J. Wood-Bealing and T. Hong Thi Duong.

Raw data and Australian and New Zealand Environment and Conservation Council (ANZECC) Guidelines for water quality are included in Appendix 6.

Analysis of the results was carried out by DBCA's Rivers and Estuaries Science Unit through one-way analysis of variance (ANOVA) tests. The parameters with the greatest level of significance were pH and specific conductivity (Figure 58). Site 7 showed consistently the highest pH and the conductivity. It also had the greatest variation in dissolved oxygen levels. Sites 3 and 4 had the lowest conductivity and the least variation at each sampling time. Temperature and dissolved oxygen had the greatest variation at most sites. Temperature was generally highest at Site 7.

ANOVA tests for turbidity, Oxidation Reduction Potential and the *E.coli* count are not included as these parameters were only measured once so there is low confidence in the analysis.



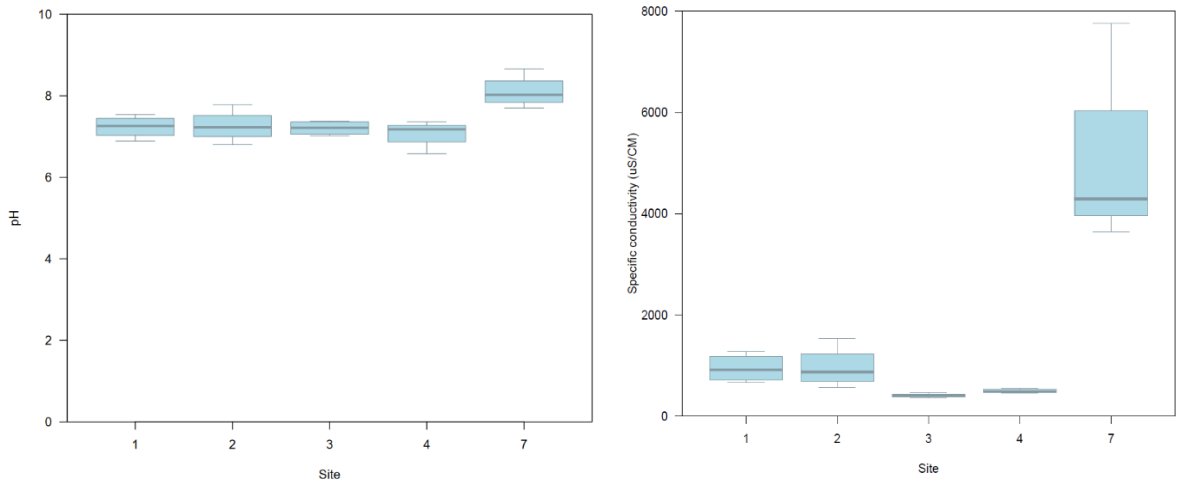


Figure 58: One-way analysis of variance (ANOVA) on temperature (top left), percent dissolved oxygen (top right), pH (bottom left) and conductivity (bottom right) values from water monitoring sites.

The wetland in the best condition (site 4) is located on land vested in DoC in Brabham. The area will be developed into a residential estate. DBCA has provided DoC with a specific report highlighting the values of Saint Leonards Creek on this land, with the aim to minimise disturbance to the creek and associated wetlands during and post development.

During the monitoring period, a concrete footpath was constructed through Watervalley Boulevard Park (site 2, Figures 59 and 60), bisecting the wetland. Sand infill and limestone revetments were part of the construction. No culverts to enable water flow were included in the design, which may eventually lead to stagnation, algal issues, sedimentation, mosquito breeding and death of the *Melaleuca* trees. This needs to be addressed with the developer.

Figures 59 and 60: Site 2 Watervalley Boulevard Park prior to pathway construction, January 2019 (left) and the completed pathway showing high levels of inundation, May 2020 (right).

Table 3: Basic site description and summary of water quality results for monitoring sites.

Site No.	Site name	Segment No.	Representative photo	Description	Summary of results
1	Jungle Park drain	85		Part of an urban drainage system. Modified remnant wetland with areas of disturbance among native vegetation.	▪ Some indications of potential acid sulphate soils, with seepage from the sediment, which should be further investigated. ▪ pH remained within acceptable limits and all other physical measures for conductivity, turbidity and dissolved oxygen were within ANZECC guidelines. There was an unconfirmed algae bloom during monitoring. ▪ Bacteria was measured on 29 February 2019 and Site 1 had the lowest mean *E. coli* concentration of 25.4 mpb/100 mL. ▪ Overall, this site was in good condition.
2	Watervalley Boulevard Park	81		An area of large, old *Melaleuca* trees, with areas of disturbance. During the monitoring period, several mature trees were removed and sandy infill was placed into the wetland to build a footpath.	▪ An increase in salinity was observed, possibly as a result of disturbance during footpath construction. ▪ Overall, the water quality at this site was within ANZECC guidelines for pH, conductivity, turbidity and dissolved oxygen. ▪ Bacteria was measured on 29 February 2019 and Site 2 had the third lowest mean *E.coli* concentration of 165.2 mpb/100 mL which exceeded the ANZECC guidelines. ▪ Overall, this site was in good condition.

Site No.	Site name	Segment No.	Representative photo	Description	Summary of results
3	Development area	56		A groundwater fed water source, with remnant vegetation along the creek line, with areas of disturbance.	▪ Water quality remained stable and within ANZECC guidelines for pH, conductivity, turbidity and dissolved oxygen. ▪ Bacteria was measured on 29 February 2019 and Site 3 had one of the highest mean *E.coli* concentration of 200.5 mpb/100 mL and exceeded the ANZECC guidelines, likely a result of surrounding landuse. ▪ Overall, this site was in good condition.
4	Frog wetland	61 and 62		Waterhole surrounded by remnant vegetation and habitat in good condition, although there are some small areas of disturbance.	▪ Water quality was within ANZECC guidelines for pH, conductivity, turbidity and dissolved oxygen. ▪ pH remained neutral and conductivity was the lowest and remained stable at this site in comparison to other sites. ▪ The presence of frogs was noted as a good indicator of ecosystem health. ▪ Bacteria was measured on 29 February 2019 and Site 4 had second lowest mean *E.coli* concentration of 94.5 mpb/100 mL which is just within the limits of ANZECC guidelines. ▪ Overall, this site was in the best condition of the eight sites monitored in terms of water quality.
5	Bridle trail	27		Straight ditch in the Henley Brook development area.	▪ Not measured because there was no surface water present at the time of monitoring.

Site No.	Site name	Segment No.	Representative photo	Description	Summary of results
6	Guard dogs	18		Located in Henley Brook on an undeveloped road alignment over the creek. Upstream of a small dam on private property.	▪ Not measured because there was no surface water present at the time of monitoring.
7	Horse farm area	15		The most disturbed site, with limited remnant vegetation and large areas of disturbance. The surrounding land practices are dominated by horse properties.	▪ There was a possible *Microcystis* and *Nodularia* algae bloom during monitoring. ▪ Conductivity was highest at this location and continuously exceeded the ANZECC guidelines. ▪ pH was highest at this location in comparison to the other sites and exceeded the ANZECC guidelines on the 8th May 2019 with an average pH reading of 8.66. ▪ Dissolved oxygen levels exceeded the ANZECC guidelines on 8th May 2019 with an average reading of 15.88mg/L. ▪ Turbidity at this site exceeded the guidelines with an average reading of 221 NTU. ▪ Bacteria was measured on 29 February 2019 and Site 7 had one of the highest mean *E.coli* concentration of 200.5 mpb/100 mL and exceeded the ANZECC guideline. ▪ Overall, this site was in poor condition.

Site No.	Site name	Segment No.	Representative photo	Description	Summary of results
8	DWER monitoring site	3		The lower reaches of Saint Leonards Creek, located on a horse property.	▪ Not measured because there was no surface water present at the time of monitoring.

Note that photos of sites 5, 6 and 8 were taken at the time of the condition assessment in October and November 2018, not at the time of water monitoring.

3.3.2 Sediment analysis

Sediment analysis for contamination with heavy metals Copper, Lead, Zinc and Cadmium was conducted at all sites, including sites 5, 6 and 8 which did not have surface water present at the time of monitoring. The analysis was carried out using atomic absorption spectroscopy. Results show that the metals analysed in sediment samples collected were within acceptable levels according to the ANZECC guidelines (Appendix 7). Most samples were below the low ANZECC guideline value.

However, sites 6 and 7, both mostly on private property, had elevated levels of cadmium between the low and high ANZECC guideline values. Site 7 also had the highest level of zinc from all sites sampled, although it was still less than the low ANZECC guideline level (Appendix 7).

4 Recommendations

4.1 General recommendations

Connected open wetland systems such as Saint Leonards Creek are often considered as the filters for the receiving water body, the Swan River in this case. These low-lying, indiscriminate riparian remnant areas allow water to slowly meander, providing time for nutrients such as phosphorus to bond to the sediments. Native riparian sedge communities provide filtration and improve water quality, whilst also providing habitat corridors and biodiversity in a fragmented natural landscape (Pen, 1999). The value of these remnant riparian areas should not be underestimated in their important function in maintaining water quality, biodiversity and amenity values for the immediate area and downstream to the Swan River.

Recommendations from DBCA's Rivers and Estuaries Branch across Saint Leonards Creek are to:

- Maintain hydrological function of tributaries and associated wetland systems;
- Remove weed species currently low in number that threaten downstream values, especially species known as prolific spreaders;
- Ensure that vegetative material from invasive weeds is not spread further during development;
- Address sedimentation and water quality issues through engagement and negotiation with landholders, developers and the City of Swan;
- Protect Whadjuk cultural values of the creek and provide opportunities to engage Noongar people in restoration activities through engaging Noongar businesses and Traditional Owners who can speak for this country; and
- Provide education material and workshops to residents to promote low fertiliser use in their gardens and the value of native plants and animals, as well as identification of invasive weed species.

***Swan Valley Planning Act* area**

- Continue to support landholders restoring the creekline on their properties and monitor native plant survival and weed invasion;
- Engage with other landholders if they express an interest in restoration;
- Restore priority sections of City of Swan easements;
- Address sedimentation and water quality issues along Lawson Road;
- Provide education material to horse owners on managing manure and other fertilisers, and providing safe stock watering that does not impact on the creek; and
- Remove *Isolepis prolifera* north of Lawson Road before it establishes in the lower reaches of the creek.

Henley Brook development area

- Engage with district and local structure planning processes to ensure that drainage is in accordance with water sensitive urban design and that creek or drainage channel buffers are revegetated with local native plants;
- Ensure revegetated and conservation areas are clearly delineated using footpaths, bollards, roads or fencing to prevent parkland or surrounding landuse encroaching into these areas;
- Provide opportunities for future residents to connect to nature by installing pathways around riparian vegetation, wildlife hides, and boardwalks or viewing platforms in sensitive areas. Provide interpretive information on the natural values in relation to the broader catchment and its connection to the Swan River; and
- Retain well-established local native trees, and non-local Eucalyptus trees that are not outcompeting native plants, to reduce temperatures and provide shade and fauna habitat in new residential developments.

Brabham development area

- Address hydrological issues in Watervalley Boulevard Park (Resource Enhancement Wetland 8805) resulting from construction of a concrete footpath and revetment through the wetland;
- Retain Pannage Wetlands (Resource Enhancement Wetland 8804), connecting vegetation, and the riparian corridor on DoC land;
- Re-evaluate riparian vegetation on DoC land under *A methodology for the evaluation of wetlands on the Swan Coastal Plain, Western Australia* (DBCA 2017) to ensure conservation values are identified and appropriate buffers are applied [note that Pannage Wetlands has been re-evaluated since the assessment];
- Remove invasive species from the drain in Dreng Park in Brabham;
- Translocate *Lepidosperma longitudinale* and *Xanthorrhoea brunonis* plants that are to be cleared to suitable areas within Saint Leonards Catchment;
- Prevent existing weeds from being further disbursed during the construction phase of development;
- Control weedy grasses and herbs that are starting to outcompete natives in Savello Park in Whiteman Edge;
- Engage with district and local structure planning processes and ensure that adequate buffers are applied to the creek and remnant vegetation is retained;
- Ensure areas of conservation value are clearly delineated using footpaths, bollards, roads or fencing to prevent parkland or surrounding landuse encroaching into high value conservation areas; and
- Provide opportunities for future residents to connect to nature by installing pathways around riparian vegetation, wildlife hides, and boardwalks or viewing platforms in sensitive areas. Provide interpretive information on the

natural values in relation to the broader catchment and its connection to the Swan River.

4.2 Specific strategies and recommendations

Actions that can be achieved in the short to intermediate term are included for each segment in Appendix 1. Each segment has also been assigned a priority category based on their conservation value, condition and value for investment. Note that other factors need to be considered when planning restoration works including the will and capacity of landholders, security of tenure and future land developments.

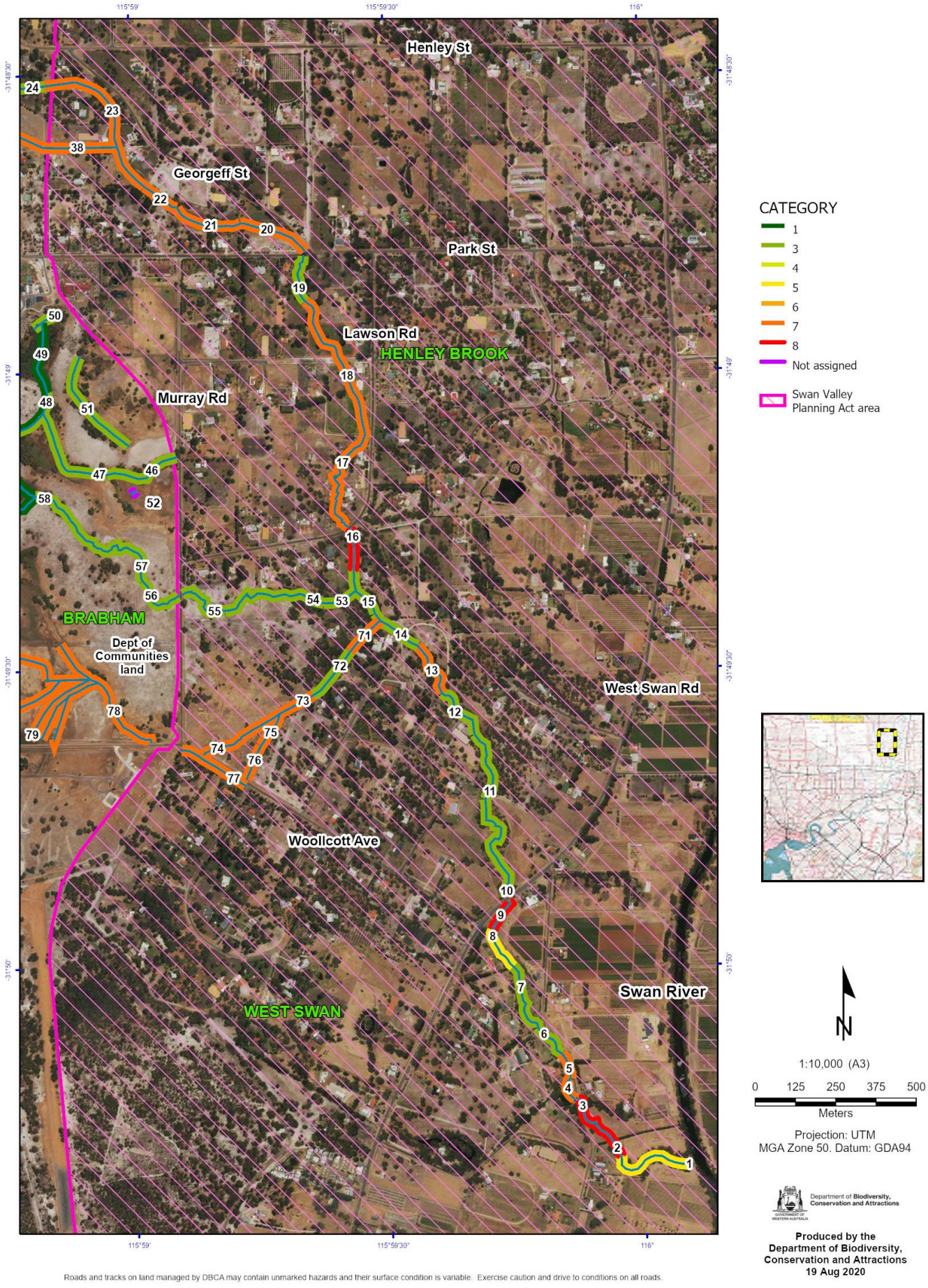


Figure 61: Prioritisation categories in the Swan Valley Planning Act *area.*

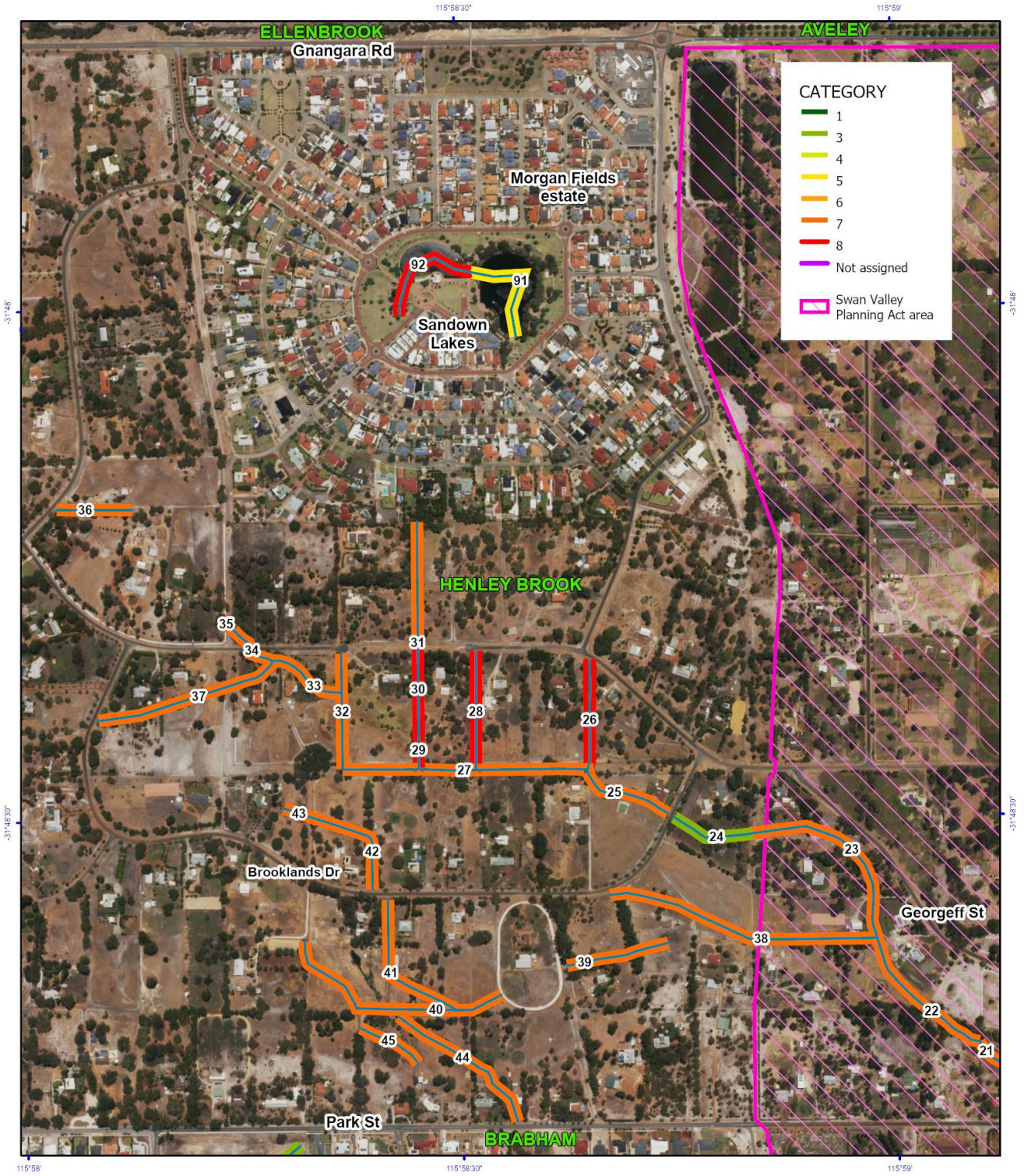
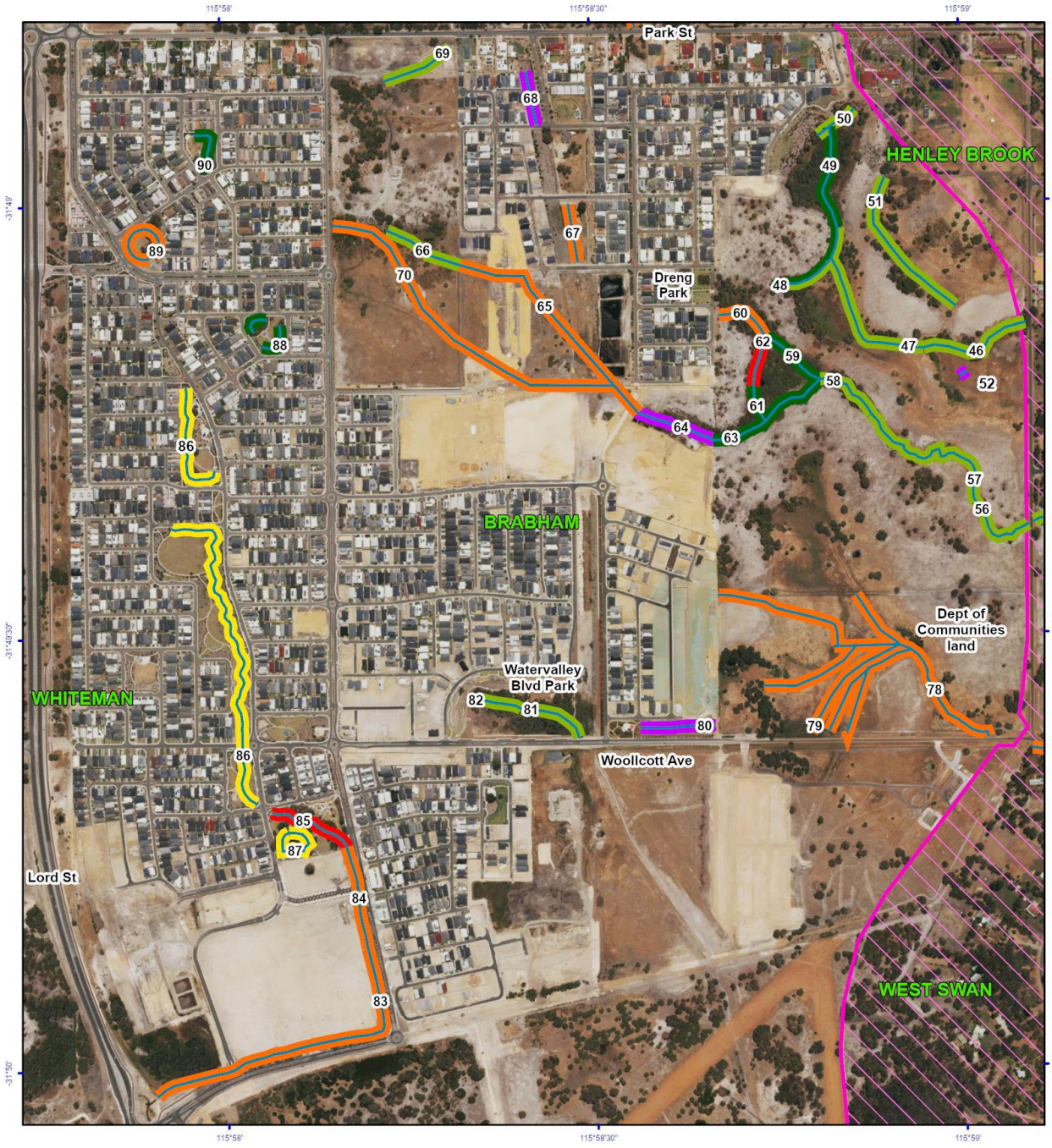


Figure 62: Prioritisation categories in the Henley Brook development area.



CATEGORY

- 1
- 3
- 4
- 5
- 6
- 7
- 8
- Not assigned
- Swan Valley Planning Act area

1:8,000 (A3)

0 125 250 375 500

Meters

Projection: UTM
MGA Zone 50. Datum: GDA94

Department of Biodiversity, Conservation and Attractions

Produced by the Department of Biodiversity, Conservation and Attractions
19 Aug 2020

Roads and tracks on land managed by DBCA may contain unmarked hazards and their surface condition is variable. Exercise caution and drive to conditions on all roads.

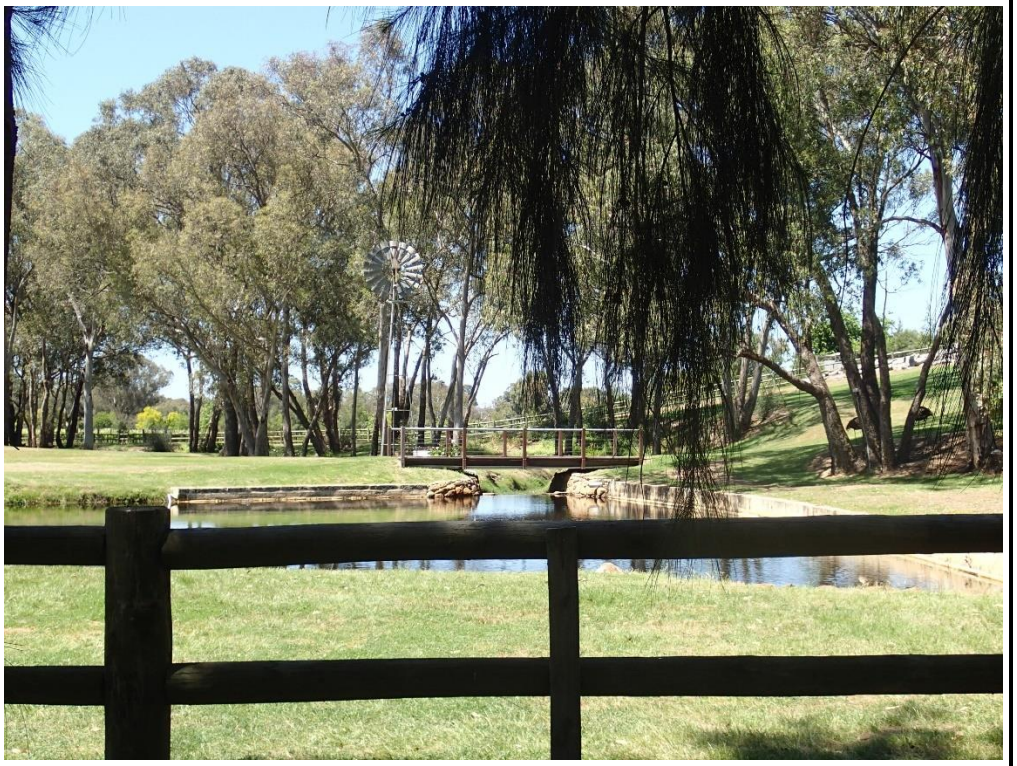
The Dept. of Biodiversity, Conservation and Attractions does not guarantee that this map is without flaw of any kind and disclaims all liability for any errors, loss or other consequence which may arise from relying on any information depicted.

Figure 63: Prioritisation categories in the Brabham development area. Note that although data analysis has identified segment 62 as a low priority, the overriding management conclusion is that it is a high priority for works due to its potential impact on high downstream values.

Appendices

Appendix 1 Recommendations for segments along Saint Leonards Creek

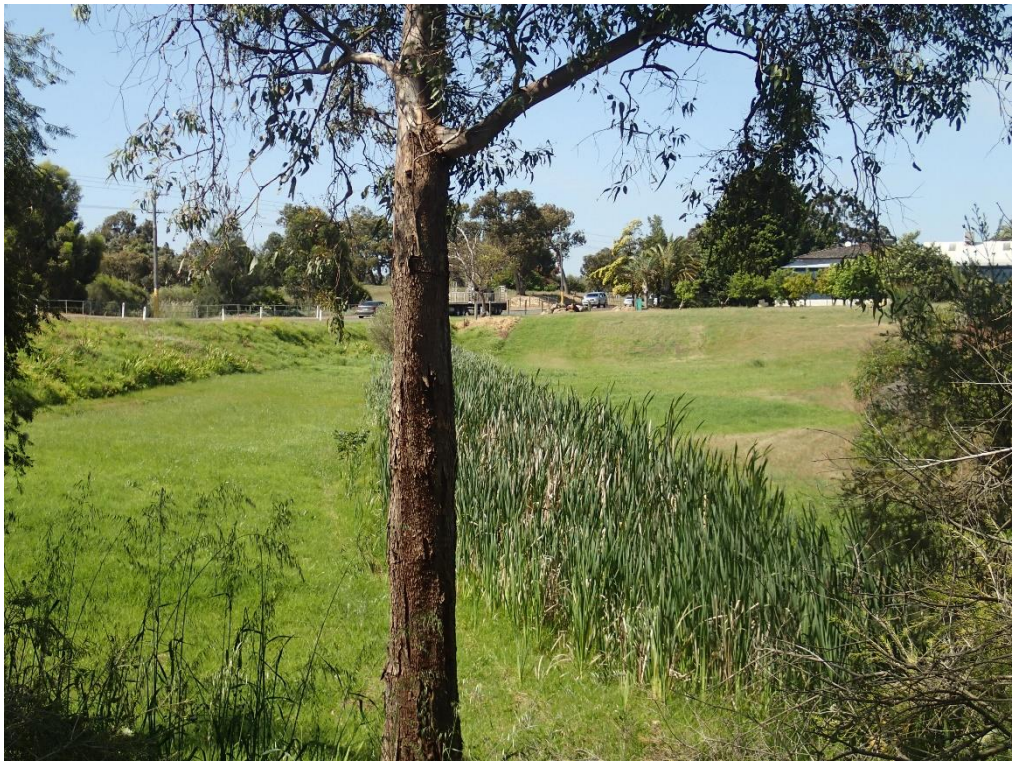
The closest street and suburb, or park name if relevant, is included for reference.

Segment 1	**George St, West Swan**	**Segment 2**	**George St, West Swan**
			
Vegetation description	*Eucalyptus rudis* over occasional *Olea europaea* and mixed weedy grasses	**Vegetation description**	Occasional *Eucalyptus rudis* over mixed weedy grasses
Recommended restoration	Plant native sedges on lower banks to replace weeds. Continue to remove Olives.	**Recommended restoration**	Plant native trees and sedges on the unwalled bank, and native trees behind the limestone wall.

Segment 3	George St, West Swan	Segment 4	George St, West Swan
			
Vegetation description	Very occasional *Corymbia calophylla* and *Melaleuca* sp. over mixed weedy grasses and herbs	**Vegetation description**	Exotic trees over *Typha sp*. and *Cenchrus clandestinus*
Recommended restoration	Restricting horse access to creek will improve erosion risk but is dependent on landholders' will. Plant native *Melaleuca* trees to provide overstorey.	**Recommended restoration**	Remove *Watsonia* and plant native sedges on bank. Manage *Typha**.

Segment 5	**George St, West Swan**	**Segment 6**	**George St, West Swan**
			
Vegetation description	*Agonis flexuosa* and Eastern States *Eucalyptus sp*. over *Rosa sp*. Dorothy Perkins, *Zantedeschia aethiopica* and *Cenchrus clandestinus*	**Vegetation description**	*Melaleuca rhaphiophylla* and *Corymbia calophylla* over *Rosa sp*. Dorothy Perkins, *Watsonia sp*., *Zantedeschia aethiopica* and weedy grasses
Recommended restoration	Would require ongoing management to be clear of weeds. Remove Black Flag as a priority. Remove weedy Passionfruit from fence.	**Recommended restoration**	Would require ongoing management to be clear of weeds. Remove woody weeds: Olive and Rose.

Segment 7	George St, West Swan	Segment 8	West Swan Road, West Swan
			
Vegetation description	*Melaleuca rhaphiophylla*, *Salix babylonica* and exotic trees over *Zantedeschia aethiopica* and weedy grasses	**Vegetation description**	Dense *Melaleuca rhaphiophylla* over sprayed weedy grasses
Recommended restoration	Plant fringing vegetation downstream of driveway creek to prevent erosion.	**Recommended restoration**	Plant right bank near active erosion. Remove Morning Glory and *Watsonia*. Control weedy grass regrowth. Plant sedges.

Segment 9	West Swan Road, West Swan	Segment 10	West Swan Road, Henley Brook
			
Vegetation description	*Typha sp*. in stream and *Cenchrus clandestinus* on bank	**Vegetation description**	*Melaleuca rhaphiophylla* over *Cenchrus clandestinus*, with some *Eucalyptus sp.* (white gum) over mixed grasses on upper bank
Recommended restoration	Work with landholder, has good relationship with neighbour and they jointly manage the creek. Plant native sedges on the banks behind the *Typha*. Plant overstorey species.	**Recommended restoration**	Control grasses and plant sedges and other understorey plants. Remove Olive and Fig.

Segment 11	Carwood Crescent, Henley Brook	Segment 12	Carwood Crescent, Henley Brook
			
Vegetation description	*Corymbia calophylla* and *Melaleuca rhaphiophylla* over *Cenchrus clandestinus* and revegetation	**Vegetation description**	*Corymbia calophylla* and *Melaleuca rhaphiophylla* over *Pteridium esculentum* and mixed grasses
Recommended restoration	Grass weed control. Remove Bridal Creeper, Arum Lily, Olive and Figs. Control foxes.	**Recommended restoration**	Remove Arum Lily and Bridal Creeper.

Segment 13	**Carwood Crescent, Henley Brook**	**Segment 14**	**Casuarina Place, Henley Brook**
			
Vegetation description	*Eucalyptus rudis* and *Melaleuca rhaphiophylla* over *Zantedeschia aethiopica*, *Cenchrus clandestinus* and other weedy grasses and herbs	**Vegetation description**	*Melaleuca rhaphiophylla* and *Schinus terebinthifolius* over sparse *Zantedeschia aethiopica* and dense *Cenchrus clandestinus*
Recommended restoration	Move culverts and address erosion around their current placement. There are too many Arum Lilies to easily remove and replace.	**Recommended restoration**	Remove Brazilian Pepper and Arum Lily. Could plant up banks, although grass invasion from adjacent property will be an ongoing issue.

Segment 15	Lawson Road, Henley Brook	Segment 16	Lawson Road, Henley Brook
			
Vegetation description	Eastern States *Eucalyptus sp.* and *Melaleuca rhaphiophylla* over *Ehrharta calycina* and other weedy grasses	**Vegetation description**	Very sparse *Melaleuca lateritia* or *Kunzea sp*. over mixed weedy grasses and herbs
Recommended restoration	Remove Brazilian Peppers on City of Swan easement. Manage *Typha**. Landholder has recommended erecting signs on Lawson Rd to warn drivers of waterbirds and other wildlife.	**Recommended restoration**	Remove Brazilian Pepper, Victorian Teatree and weedy Acacia. Control grassy bank. Infill revegetation. Involve landowner on right bank. Water quality management is needed at the north of the segment.

Segment 17	Lawson Road, Henley Brook	Segment 18	Lawson Road, Henley Brook
			
Vegetation description	Eastern States *Eucalyptus sp.* over mixed weedy grasses	**Vegetation description**	*Juncus microcephalus* over *Cenchrus clandestinus* and other mixed weedy grasses and herbs
Recommended restoration	Remove Brazilian Pepper and *Isolepis prolifera*. Fence creek if there's interest from landholders.	**Recommended restoration**	Encourage owners to plant natives. Stage replacing *Juncus microcephalus* with native sedges; remove *Isolepis prolifera* from road reserve. Remove silt.

Segment 19	Park Street, Henley Brook	Segment 20	Park Street, Henley Brook
			
Vegetation description	*Corymbia calophylla* over *Melaleuca rhaphiophylla* over *Typha sp*. and *Colocasia esculenta*	**Vegetation description**	Mixed *Eucalyptus sp*. over *Typha sp*. and mixed grasses
Recommended restoration	Remove *Isolepis prolifera*, Fig, Brazilian Pepper. Allow *Lepidosperma longitudinale* and other natives to regenerate at south east corner.	**Recommended restoration**	Grass weed control. May also need slashing to reduce fire hazard and seed bank. Remove Fig, *Arundo*, Brazilian Pepper, Pampas Grass. Plant natives.

Segment 21	**Park Street, Henley Brook**	**Segment 22**	**Georgeff Street, Henley Brook**
			
Vegetation description	Sparse *Eucalyptus sp*. over *Juncus pallidus*, *J. microcephalus*, weedy grasses and herbs	**Vegetation description**	*Eucalyptus rudis* and other *Eucalyptus sp*. over *Cenchrus clandestinus* and other weedy grasses
Recommended restoration	Control Kikuyu. Allow *Juncus pallidus* to regenerate and plant local native plants including overstorey species.	**Recommended restoration**	Slash or control grasses floodplain, not along the edge of creek unless planting as that may destabilise soil.

Segment 23	Georgeff Street, Henley Brook	Segment 24	Brooklands Drive, Henley Brook
			
Vegetation description	Weedy grasses and herbs	**Vegetation description**	Sparse *Eucalyptus rudis* over *Melaleuca viminea*, *Juncus pallidus* and mixed grasses
Recommended restoration	Consider fencing to limit horse access. Plant overstorey and *Juncus pallidus* along creek and around dam.	**Recommended restoration**	Area is zoned for development. Review drainage and development plans. Plant trees, *Centella asiatica* and other understorey natives. Control grasses on upper banks.

Segment 25	Brooklands Drive, Henley Brook	Segment 26	Henley Street, Henley Brook
			
Vegetation description	*Eucalyptus* sp. possibly *E. citriodora* or *E. camaldulensis* over weedy grasses and herbs	**Vegetation description**	*Corymbia calophylla*, Eastern States *Eucalyptus* sp. and *E. rudis* over weedy grasses
Recommended restoration	Area is zoned for development. Review drainage and development plans. Remove pump and pipe, control grasses, plant native trees at downstream end and plant understorey.	**Recommended restoration**	Area is zoned for development. Review drainage and development plans. Remove small Eastern States *Eucalyptus sp.* Control grasses and revegetate. Remove Nasturtium. Contain weedy grasses from adjacent paddock.

Segment 27	Brooklands Drive, Henley Brook	Segment 28	Henley Street, Henley Brook
			
Vegetation description	Mixed Eastern States *Eucalyptus* sp. over weedy grasses	**Vegetation description**	*Eucalyptus rudis* over weedy grasses
Recommended restoration	Area is zoned for development. Review drainage and development plans. Manage grassy weeds and Nut Grass. Hard to plant with wetland species as water is temporary.	**Recommended restoration**	Area is zoned for development. Review drainage and development plans. Control grasses and plant understorey.

Segment 29	**Henley Street, Henley Brook**	**Segment 30**	**Henley Street, Henley Brook**
			
Vegetation description	*Eucalyptus rudis* over *Cenchrus clandestinus*	**Vegetation description**	*Corymbia calophylla* and mixed Eastern States *Eucalyptus* sp. over weedy grasses
Recommended restoration	Area is zoned for development. Review drainage and development plans. Remove the 1 Brazilian Pepper on the left bank. Control grasses and plant understorey. Move left bank fence further back behind the tree line.	**Recommended restoration**	Area is zoned for development. Review drainage and development plans. Remove the 1 Brazilian Pepper on the right bank. Remove Flinders Range Wattles. Continue controlling understorey weeds.

Segment 31	Henley Street, Henley Brook	Segment 32	Henley Street, Henley Brook
			
Vegetation description	No overstorey. Weedy grasses	**Vegetation description**	Very open weedy *Casuarina* sp. over weedy grasses and herbs
Recommended restoration	Area is zoned for development. Review drainage and development plans. Rehabilitation easier if the cows can be removed. Plant overstorey and sedges. Control Veldt Grass if revegetating.	**Recommended restoration**	Area is zoned for development. Review drainage and development plans. Would need to fence on right bank and plant if doing anything.

Segment 33	**Henley Street, Henley Brook**	**Segment 34**	**Henley Street, Henley Brook**
			
Vegetation description	Garden palms, fruit trees and other exotic trees over weedy grasses	**Vegetation description**	Mixed exotic trees over mixed weedy grasses
Recommended restoration	Area is zoned for development. Review drainage and development plans.	**Recommended restoration**	Area is zoned for development. Review drainage and development plans.

Segment 35	Henley Street, Henley Brook	Segment 36	Andrea Drive, Henley Brook
			
Vegetation description	Eastern States *Eucalyptus* sp. over *Avena barbata* and *Ehrharta calycina*	**Vegetation description**	Eastern States *Eucalyptus* sp. over *Melaleuca preissiana* over weedy grasses
Recommended restoration	Area is zoned for development. Review drainage and development plans. Wetland plants unlikely to survive here - substrate too dry and almost no water flow year-round.	**Recommended restoration**	Area is zoned for development. Review drainage and development plans. Little hope of this being a creek again. Wetland plants unlikely to survive here - substrate too dry and almost no water flow year-round.

Segment 37	**Henley Street, Henley Brook**	**Segment 38**	**Brooklands Drive, Henley Brook**
			
Vegetation description	Open Eastern States *Eucalyptus* sp. and *Pinus* sp. over *Ehrharta* sp.	**Vegetation description**	Very open mixed *Eucalyptus* sp. over mixed weedy grasses
Recommended restoration	Area is zoned for development. Review drainage and development plans. Barely a creek any longer so planting wetland species is unlikely to be effective. Establish an overstorey by planting dryland trees and shrubs.	**Recommended restoration**	Area is zoned for development. Review drainage and development plans.

Segment 39	Brooklands Drive, Henley Brook	Segment 40	Brooklands Drive, Henley Brook
			
Vegetation description	Occasional Eastern States *Eucalyptus* sp. over dried weedy grasses	**Vegetation description**	Very open *Eucalyptus* sp. over mixed weedy grasses and herbs
Recommended restoration	Area is zoned for development. Review drainage and development plans.	**Recommended restoration**	Area is zoned for development. Review drainage and development plans. Mervac developers may retain the large Eastern States Eucalyptus.

Segment 41	Brooklands Drive, Henley Brook	Segment 42	Brooklands Drive, Henley Brook
			
Vegetation description	Open Eastern States *Eucalyptus* sp. over dried out weedy grasses and herbs	**Vegetation description**	*Eucalyptus rudis* over weedy grasses
Recommended restoration	Area is zoned for development. Review drainage and development plans.	**Recommended restoration**	Area is zoned for development. Review drainage and development plans. If not to be redeveloped, fence left bank and clear out culvert near easement.

Segment 43	Brooklands Drive, Henley Brook	Segment 44	Park Street, Henley Brook
			
Vegetation description	Open *Eucalyptus rudis* over *Juncus pallidus* and mixed grasses	**Vegetation description**	Eastern States *Eucalyptus* sp. and exotic trees over fruit trees and *Cynodon dactylon*
Recommended restoration	Area is zoned for development. Review drainage and development plans. If not to be redeveloped, restrict sheep access to sedges. Revegetate with more sedges and diverse wetland plants.	**Recommended restoration**	Area is zoned for development. Review drainage and development plans. Mervac may retain the large Eastern States Eucalyptus. Remove Castor Oil. Plant dryland sedges and overstorey species.

Segment 45	**Park Street, Henley Brook**	**Segment 46**	**Murray Road, Brabham** DoC land
			
Vegetation description	Eastern States *Eucalyptus* sp. over mixed weedy grasses and scattered *Juncus pallidus*	**Vegetation description**	*Melaleuca preissiana* over *Melaleuca lateritia, Centella asiatica*, mixed weedy grasses and some *Lepidosperma longitudinale*
Recommended restoration	Area is zoned for development. Review drainage and development plans. Plant the easement over the Dampier Bunbury gas pipeline with local native species including sedges.	**Recommended restoration**	Retain as much of the overstorey as practicable during development.

Segment 47	**Murray Road, Brabham** DoC land	**Segment 48**	**Murray Road, Brabham** DoC land
			
Vegetation description	Very open *Melaleuca preissiana* and *Corymbia calophylla* over *Lepidosperma longitudinale, Baumea preissii* and some *Xanthorrhoea brunonis*	**Vegetation description**	*Corymbia calophylla* and *Melaleuca preissiana* over *Lepidosperma longitudinale*
Recommended restoration	Remove Cottonbush. Retain sedges or as a last resort if the area is to be cleared, transplant sedges, particularly *Lepidosperma longitudinale*.	**Recommended restoration**	Hand pull Fleabane. Control any Arum lily on left bank. Retain remnant vegetation as it provides a corridor between high value areas and contains some Cockatoo trees.

Segment 49	**Pannage Wetlands, Brabham** DoC land	**Segment 50**	**Pannage Wetlands, Brabham** DoC land
			
Vegetation description	*Melaleuca rhaphiophylla* over *Baumea articulata. Lepidosperma longitudinale* and *Xanthorrhoea preissii* on edges	**Vegetation description**	Open *Melaleuca preissiana* and *Melaleuca rhaphiophylla* over *Baumea articulata. Paspalum, Lepidosperma longitudinale* and *Cenchrus clandestinum* on edges
Recommended restoration	High priority to protect and retain. Remove Lantana, Blackberry, Tree fern and Figs. Engage the community in protecting this area.	**Recommended restoration**	Hand pull Fleabane and Dock. Grass selective weed control. Manage small pockets of *Typha*.*

Segment 51	**Murray Road, Brabham** DoC land	**Segment 52**	**Murray Road, Brabham** DoC land
			
Vegetation description	*Melaleuca preissiana* over *Xanthorrhoea preissii, X. brunonis* and *Lepidosperma longitudinale*	**Vegetation description**	*Juncus kraussii* stand
Recommended restoration	Transplant *Xanthorrhoea brunonis* if this area is to be cleared. Remove Figs and Apple of Sodom.	**Recommended restoration**	If this section of sedges is to be removed during development, transplant to a suitable restoration site.

Segment 53	**Lawson Road, Henley Brook**	**Segment 54**	**Lawson Road, Henley Brook**
			
Vegetation description	*Melaleuca rhaphiophylla* over *Centella asiatica*, *Juncus pallidus* and *Cenchrus clandestinus*	**Vegetation description**	*Melaleuca preissiana* and *Acacia saligna* over *Centella asiatica*, *Juncus pallidus* and mixed grasses and herbs
Recommended restoration	Remove Brazilian Pepper.	**Recommended restoration**	Grass selective weed control. Remove Arum Lilies. Plant native sedges.

Segment 55	Lawson Road, Henley Brook	Segment 56	Murray Road, Brabham DoC land
			
Vegetation description	Open dead *Corymbia calophylla* over *Melaleuca preissiana* or *M. viminea* and weedy grasses and herbs	**Vegetation description**	*Melaleuca viminea* over *Juncus pallidus*, *J. microcephalus, Centella asiatica* and mixed grasses
Recommended restoration	Issue letter from City of Swan regarding Cottonbush. Remove Brazilian Pepper, Sydney Golden Wattle and Arum Lily.	**Recommended restoration**	Selectively remove *Juncus microcephalus* to minimise impact on *Centella* and Budding Club-Rush. Remove Apple of Sodom and Fig. Plant banks if *J. microcephalus* is removed.

Segment 57	**Murray Road, Brabham** DoC land	**Segment 58**	**Murray Road, Brabham** DoC land
			
Vegetation description	*Melaleuca viminea over Juncus pallidus, Centella asiatica* and weedy grasses and herbs, with *Corymbia calophylla, Xanthorrhoea preissiana* and *Dasypogon bromeliifolius* on upper banks	**Vegetation description**	*Corymbia calophylla* and *Melaleuca viminea* over *Lepidosperma longitudinale, Centella asiatica,* weedy grasses and scattered *Juncus pallidus*
Recommended restoration	Remove Apple of Sodom, Cottonbush, Fig, Arum lily. Conduct grass selective weed control. Plant transitional species on upper banks.	**Recommended restoration**	Remove Fig and Arum lily. Control grassy edge to prevent invasion to dense sedgeland. Collect and propagate *Melaleuca* and *Corymbia* seed. Plant transitional species on upper banks.

Segment 59	**Palfrey Street, Brabham** DoC land	**Segment 60**	**Drain from Dreng Park, Brabham** DoC land
			
Vegetation description	*Melaleuca rhaphiophylla* over *Lepidosperma longitudinale*	**Vegetation description**	*Melaleuca preissiana* over *Typha, Cenchrus clandestinus, Cirsium vulgare* and other weedy grasses and herbs
Recommended restoration	Selectively control grasses on edge of riparian zone. Install boardwalks or trails, without compromising existing vegetation, to engage residents in local natural values.	**Recommended restoration**	Remove weeds as a priority as they are a major source of infestations downstream and threaten high natural values.

Segment 61	**Palfrey Street, Brabham** DoC land	**Segment 62**	**Palfrey Street, Brabham** DoC land
			
Vegetation description	*Melaleuca rhaphiophylla* over *Lepidosperma longitudinale*	**Vegetation description**	*Melaleuca viminea* over *Isolepis prolifera, Centella asiatica, Ficus carica* and *Lepidosperma longitudinale*
Recommended restoration	Selectively control grasses on edge of riparian zone. Monitor for weeds from drain upstream. Install boardwalks and trails to connect residents to local natural values.	**Recommended restoration**	Remove *Isolepis prolifera* as a high priority as it threatens high condition vegetation. Consider a solarisation trial with UV stabilised black plastic. Remove Figs.

Segment 63	**Palfrey Street, Brabham** DoC land	**Segment 64**	**Mormaer Street, Brabham** Flamewood estate
			
Vegetation description	*Corymbia calophylla* over *Melaleuca viminea*, *Astartea scoparia* and *Lepidosperma longitudinale*	**Vegetation description**	Not assessed as access wasn't possible due to construction. Some remnant riparian vegetation is present.
Recommended restoration	Monitor for sediment and weeds from upstream development. Remove *Watsonia* and Bridal Creeper. Selectively control grasses on edge of riparian zone.	**Recommended restoration**	Retain remnant vegetation and ensure adequate buffers.

Segment 65	**Fairmount Boulevard, Brabham** Ariella estate	**Segment 66**	**Fairmount Boulevard, Brabham** Ariella estate
			
Vegetation description	Very scattered *Melaleuca preissiana* over *Juncus pallidus* in patches, mixed pasture grasses and other weedy herbs	**Vegetation description**	*Melaleuca preissiana* over *Lepidosperma longitudinale* and *Xanthorrhoea brunonis* in low-lying area, surrounded by *Corymbia calophylla* and *Banksia* over *X. preissiana*, *X. brunonis* and weedy grasses
Recommended restoration	Retain *Melaleuca preissiana*. Maintain the compensation basin and remove weeds. Revegetate with local native species where possible.	**Recommended restoration**	Retain as much vegetation as possible. Contains some of the best condition vegetation on the creek system. Translocate *Lepidosperma longitudinale* if any clearing is planned.

Segment 67	**Constable Street, Brabham** Avonlee estate	**Segment 68**	**Arpent Link, Brabham** Avonlee estate
			
Vegetation description	*Ricinus communis* over *Cenchrus clandestinus*; *Verbesina encelioides* and other weeds. Small stand of *Melaleuca preissiana*, *Typha* sp. and *Lepidosperma longitudinale*	**Vegetation description**	Revegetated mixed native species
Recommended restoration	Review drainage and development plans. Retain Jarrah, Marri and *Melaleuca preissiana*. Prevent spread of weeds. Water and infill plant revegetation on gas pipeline easement.	**Recommended restoration**	Maintain current management regime.

Segment 69	**Park Street, Brabham** Ariella estate	**Segment 70**	**Palfrey Street, Brabham** Ariella estate
			
Vegetation description	*Lepidosperma longitudinale* and *Dielsia stenostachya* sedgeland. *Corymbia calophylla* over *Xanthorrhoea preissiana* and *Dasypogon bromeliifolius* on edge	**Vegetation description**	Low *Melaleuca preissiana* over *Xanthorrhoea preissii*, *Gomphocarpus fruticosus* and other weedy grasses and herbs
Recommended restoration	Review drainage and development plans. Contains some of the best condition vegetation on the creek system. Stage removal of Eastern States Eucalyptus and *Acacia longifolia*.	**Recommended restoration**	Review drainage and development plans. Retain remnant vegetation as much as possible. Remove Cottonbush as a top priority. Remove Pampas Grass and Figs.

Segment 71	Casuarina Place, Henley Brook	Segment 72	Casuarina Place, Henley Brook
			
Vegetation description	Very occasional *Melaleuca rhaphiophylla* and Eastern States *Eucalyptus* sp. (White gums) over *Canna* sp. and mixed grasses	**Vegetation description**	*Melaleuca rhaphiophylla* over low weedy grasses and herbs
Recommended restoration	Would need major works to restore original creekline. Replace Canna Lilies with native sedges and plant behind limestone blocks on left bank.	**Recommended restoration**	Plant sedges and mid storey species (weeds are currently low in height and creek is easy to access).

Segment 73	**Casuarina Place, Henley Brook** DoC land	**Segment 74**	**Woollcott Avenue, Henley Brook** DoC land
			
Vegetation description	*Melaleuca rhaphiophylla* over *Juncus pallidus* and weedy grasses	**Vegetation description**	Mixed weedy herbs and grasses. No overstorey
Recommended restoration	Review wetland and compensation basin plans for this area. Ensure plans include local native species to provide habitat and shade over the water. Remove Candelabra Aloe.	**Recommended restoration**	Review wetland and compensation basin plans for this area. Ensure plans include local native species to provide habitat and shade over the water.

Segment 75	**Woollcott Avenue, Henley Brook** DoC land	**Segment 76**	**Woollcott Avenue, Henley Brook** DoC land
			
Vegetation description	*Melaleuca rhaphiophylla* over mixed grasses and herbs	**Vegetation description**	Annual grasses and herbs
Recommended restoration	Liaise with City of Swan to reduce further native vegetation damage during future management. Remove inkweed. Control grasses and revegetate. Ensure wetland management plans use local native species to provide habitat and shade over the water.	**Recommended restoration**	Ensure wetland development plans use locally native species to provide habitat and shade over the water. Remove blockage in creek near fenceline which is slowing flow and causing localised flooding.

Segment 77	**Woollcott Avenue, West Swan**	**Segment 78**	**Woollcott Avenue, Henley Brook** DoC land
			
Vegetation description	Mixed planted trees and shrubs over *Cenchrus clandestinus* and mixed weedy grasses and herbs	**Vegetation description**	*Melaleuca viminea* over *Isolepis prolifera, Centella asiatica, Ficus carica* and *Lepidosperma longitudinale*
Recommended restoration	Limited in ability to restore the drain because it gets road stormwater and paddock runoff and is a very narrow area.	**Recommended restoration**	Ensure weedy material, particularly Cottonbush, does not spread during clearing and construction.

Segment 79	**Woollcott Avenue, Henley Brook** DoC land	**Segment 80**	**Woollcott Avenue, Brabham** Flamewood estate
			
Vegetation description	Scattered *Gomphocarpus fruticosus, Dittrichia graveolens* and *Rumex crispus* over mixed weedy grasses	**Vegetation description**	Mixed revegetated trees, shrubs and sedges
Recommended restoration	Ensure weedy material, particularly Cottonbush, does not spread during clearing and construction.	**Recommended restoration**	Contact site maintenance contractor to recommend removing emerging invasive species. Manage *Typha**.

Segment 81	**Watervalley Boulevard Park, Brabham** Ariella estate	**Segment 82**	**Watervalley Boulevard Park, Brabham** Ariella estate
			
Vegetation description	*Melaleuca rhaphiophylla* over *Centella asiatica*, *Juncus pallidus* and *J. microcephalus*	**Vegetation description**	*Melaleuca preissiana* over *Juncus microcephalus*, *Isolepis prolifera*, *Gomphocarpus fruticosus* and weedy grasses
Recommended restoration	Address hydrological issues resulting from construction of revetment through wetland. Remove *Isolepis prolifera*, Fig, Castor Oil, Cottonbush. Plant native grass *Hemarthria uncinata*. Manage *Typha**.	**Recommended restoration**	Monitor sediment movement from estate. Remove Fig, *Isolepis prolifera*, Cottonbush. Control weeds in understorey and revegetate. Manage *Typha**.

Segment 83	**Youle Dean Road, Brabham** Whiteman Edge estate	**Segment 84**	**Everglades Avenue, Brabham** Whiteman Edge estate
			
Vegetation description	Eastern States *Eucalyptus* sp. over *Acacia saligna*, sparse understorey weeds and *Juncus pallidus*	**Vegetation description**	Eastern States *Eucalyptus* sp. over sparse weeds and sandy ditch
Recommended restoration	Stabilise embankment. Hand pull fleabane. Plant native shrubs and sedges. Potential for a restoration project and interpretational signage in a visible location adjacent to proposed shopping centre.	**Recommended restoration**	Plant densely. Install meanders in creekline and/or install jute matting to stop sand falling into creek. Remove Sydney Golden wattle but leave Eucalyptus overstorey.

Segment 85	**Jungle Park, Brabham** Whiteman Edge estate	**Segment 86**	**Mayfield Drive, Brabham** Whiteman Edge estate
			
Vegetation description	No overstorey. Revegetated landscaped plants using natives and native hybrids	**Vegetation description**	Very open young *Melaleuca rhaphiophylla*, *M. preissiana* and *Corymbia ficifolia* over mixed sedges and native landscape plants
Recommended restoration	Plant a dense sedge bed; monitor for weeds and remove. Manage young *Typha**; manage deciduous trees (remove fallen leaves in creek periodically) and plant overstorey.	**Recommended restoration**	Remove *Juncus microcephalus* and monitor for new weeds. Manage emerging *Typha**. Infill plant on bank, especially where banks are subsiding. Plant more overstorey trees.

Segment 87	**Jungle Park, Brabham** Whiteman Edge estate	**Segment 88**	**Portola Park, Brabham** Whiteman Edge estate
			
Vegetation description	*Melaleuca rhaphiophylla* over *Juncus pallidus* in basin and *Baumea preissii* and native landscape plants on edge	**Vegetation description**	*Melaleuca thymoides* over *Juncus kraussii*, *Grevillea crithmifolia* and *Calothamnus sp*.
Recommended restoration	Maintain current management – hand weed emerging weeds and allow native plant regeneration. Plant more overstorey plants. Remove blown in domestic rubbish.	**Recommended restoration**	Monitor for weeds and hand pull if required. Could control weeds in open area near bubble up drain.

Segment 89	**Savello Park, Brabham** Whiteman Edge estate	**Segment 90**	**Heisler Park, Brabham** Whiteman Edge estate
			
Vegetation description	*Corymbia calophylla* over *Xanthorrhoea preissii* in central mound of park, with *Juncus kraussii* and *Cyperus* sp. in constructed moat	**Vegetation description**	*Corymbia calophylla* over *Cenchrus clandestinus*, and *Melaleuca preissiana* over *Juncus kraussii*
Recommended restoration	Rehabilitation is hard as it ideally needs to be redesigned. Too small to be viable for wildlife. Put jute matting on slope under Marri and plant. Remove Nut Grass. Manage emerging *Typha**.	**Recommended restoration**	Monitor for weeds and hand pull.

Segment 91	**Sandown Park, Henley Brook** Morgan Fields estate	**Segment 92**	**Sandown Park, Henley Brook** Morgan Fields estate
			
Vegetation description	Eastern States *Eucalyptus* sp. and *Melaleuca* sp. over *Ficinia nodosa*, *Baumea articulata* and various native plants	**Vegetation description**	*Salix babylonica* and ornamental trees over *Cenchrus setaceus*, *Gazania sp.* and mowed grasses
Recommended restoration	Investigate if drain outlet can be modified to avoid trapping fauna. Maintain weed control inside the kerbed area and gradually replace non-local plants.	**Recommended restoration**	Gradually replace non-local species with local native plants, particularly Lantana. Notify DPIRD of Pearl Cichlids in the upper lakes [done].

**Refer to Section 3.1.4 for advice on managing* Typha*.*

Appendix 2 Landholder consultation summary

Note that only the landholders who we were able to make phone contact with, and/or who we met during the field assessment have been included.

***Swan Valley Planning Act* area**			
Street and suburb	**Reference**	**Method and date of discussion**	**Discussion details**
George St West Swan	Resident 1	Phone call on 19/10/2018 and met during assessment on 25/10/2018	Family ancestors have lived in the area since at least the 1950s and used to grow and dry fruit but have removed those trees and now have a hobby horse farm. Their main concern was boats which speed along the Swan River disturbing birds and other wildlife. They stated the best thing we could do is to enforce the river speed limit. They occasionally see a brown sludge coming through the creek. The family also used to own the property where the creek flows into the Swan River. The creek's alignment near the confluence hasn't changed in at least 70 years. The current owner of this property removes olive trees along the creek.
George St West Swan	Resident 2	Phone call on 19/10/2018	Mentioned that wastewater was pumped downstream from a subdivision off Woollcott Ave in Brabham. It looked like brown mud and many things died in the creek on their property after this.
George St West Swan	Resident 3	Phone call on 19/10/2018 and met during assessment on 25/10/2018	Landholder controls weeds on the property and says they see ducks, coots and turtles. They have controlled Morning Glory, Lantana and grasses, and are currently removing Brazilian Pepper. They harvest figs and so wouldn't remove the Fig Trees.
Casuarina Pl Henley Brook	Resident 4	Phone call on 19/10/2018 and met during	Landholder has lived next to the creek for many years. A racetrack was built across the creek, but the owner said that horses do not access the creek on the property anymore.

***Swan Valley Planning Act* area**			
Street and suburb	**Reference**	**Method and date of discussion**	**Discussion details**
		assessment on 25/10/2018	
Casuarina Pl Henley Brook	Resident 5	Phone call on 19/10/2018 and met during assessment on 26/10/2018	The family has seen many changes in the area with the developments upstream in Brabham. They mentioned the creek is periodically cleaned out (i.e. sediment removed) by the City of Swan. The City was due through a couple of weeks after the assessment.
Lawson Rd Henley Brook	Resident 6	Met during assessment on 1/11/2018	Landholder regularly mows annual grasses on the easement next to the property to provide a pathway for ducks and other animals to escape foxes. Ducks and kangaroos are seen regularly. She rides horses in the nearby dam when there's enough water in it. She had concerns about turtles and other wildlife being hit by traffic near the creek crossing.
Lawson Rd Henley Brook	Resident 7	Phone call on 19/10/2018	Landholder asked if we were doing any water quality monitoring as the creek often smells and is concerned about what is happening to it with the surrounding urban development. Years ago their children used to catch yabbies [possibly gilgies] in the creek but they don't see them anymore.
Lawson Rd Henley Brook	Resident 8	Phone call on 22/10/2018	Landholder has issues with sediment coming from upstream that blocks their pipes and in heavy rainfall they get lots of brown sludge. The City of Swan dug out the sediment in the pipe which has helped a lot with the flow.
Lawson Rd Henley Brook	Resident 9	Phone call on 19/10/2018 and met during	Landholder has lived in area for at least 30 years and now only runs one horse which has unfenced access to the creek. Said that the property downstream has put in two bores and uses the water to keep the horse paddocks green through summer.

***Swan Valley Planning Act* area**			
Street and suburb	**Reference**	**Method and date of discussion**	**Discussion details**
		assessment on 1/11/2018	Said that the culvert between Resident 9's property and the downstream property isn't wide enough to take winter flows without getting blocked with grass or sediment.
Park St Henley Brook	Resident 10	Phone calls on 5/10/2018 and 19/10/2018	Landholder said there were lots of dead branches and other dead material in the creek when she moved into the property. She has been busy 'cleaning up' the creek and protecting the wildlife. Sees lots of ducks, some turtles and other water birds using the creek as it is usually wet all year round and she is concerned about the development nearby and the impact on wildlife.
Lawson Rd Henley Brook [on a branch of St Leonards that flows from Brabham]	Resident 11	Phone call on 12/11/2018	Landholder has noticed more water in the creek and more kangaroos following residential developments in Brabham. She is concerned about the impact on wildlife from the development and animals being trapped. She moved in four years ago and has done lots of 'cleaning out' to get the water flowing. Says they need help maintaining the waterway. Finds that they need to replace filters for bore water every four months instead of six as they get clogged with sediment.
Park St Henley Brook	Resident 12	Phone calls on 8/10/2018 and 12/11/2018	Landholders do not live on the property but have planted trees and shrubs on the upper slopes of the property and now in the creekline with funding from DBCA. They have a pesticide free approach and undertake a high level of maintenance of plants and weeds.
Park St Henley Brook	Resident 13	Phone call on 12/11/2018	Have lived on the property for at least 30 years. They said the creek hasn't been cleaned out in about 25 years and it is pretty silted up.
Georgeff St Henley Brook	Resident 14	Phone call on 12/11/2018	Landholder doesn't fertilise in the back paddock, and the grass still stays green. The neighbours pick up their horses' droppings twice a day. The creek used to flow, and the landholder would see frogs but it now dries out partway through summer. He used to have bulrushes growing naturally but the neighbour

Swan Valley Planning Act area			
Street and suburb	**Reference**	**Method and date of discussion**	**Discussion details**
			slashed them. There aren't many kangaroos but there are lots of ducks which take shelter in a small dam and in the landholder's pool.
Georgeff St Henley Brook	Resident 15	Phone call on 26/11/2018	Landholders have been on property for 30 years. They received a notice from City of Swan about 20 years ago asking if they wanted to plant trees [Eastern States species] which the City would provide. They planted trees and now have a dense overstorey but many of the surrounding landholders didn't take up the offer. Landholder mentioned the water authority (possibly Water Corporation or DWER, not the City) used to 'clean out' and straighten the creek but haven't done so for years. A spring on the north side of Henley St at the end of the eastern cul-de-sac which used to have an old (1900s planted) pine plantation on it - this was over pumped (he thinks by the water authority) and the plantation died and the landowners were compensated. The creek didn't flow for about eight years, but it has recently. It used to have water each year up until February. When their children were small the flows were high after rainfall and the sandy banks would be black with crayfish, which they see anymore. They occasionally see black or brown sludge coming down the creek.
Henley St Henley Brook	Resident 16	Phone call on 12/11/2018 and during assessment on 16/11/2018	Landholder has been on the block for 30 years and hasn't seen a lot of change other than a drying climate. They see the odd kangaroo and lots of birds.

Proposed development area in Henley Brook			
Street and suburb	**Reference**	**Method and date of discussion**	**Discussion details**
Brooklands Dr Henley Brook	Resident 17	Phone call on 14/3/2019	Landholder has recently sold the property to a developer but still has access to the property for the next few years. Hasn't seen water in the creek for at least five years. The water table dropped once Morgan Fields estate was developed. Back paddock used to flood and grass grew tall. The family used to live along Lawson Rd and there was lots of water on the property. In the early 1970s the sound of frogs was deafening at night-time. Their children used to catch tadpoles and yabbies [possibly gilgies]. They used to see turtles too.
Brooklands Dr Henley Brook	Resident 18	Phone call on 14/3/2019 and met during assessment on 15/3/2019	Landholders said that the creek is very shallow and gets hardly any water.
Brooklands Dr Henley Brook	Resident 19	Phone call on 8/10/2018	Landholder said the area was about to be rezoned urban and the bridle trail will be redeveloped into a road (Pine St). He rang the City of Swan some time ago and said he had a creek on his property and he was told it wasn't a creek and is a drain instead [which is incorrect]. The creek has been straightened and takes the drainage from Morgan Fields estate.
Brooklands Dr Henley Brook	Resident 20	Site visit on 15/3/2019	Landholder said she had no idea there was a creek on her property. She has a damp area in her paddock where the cows and horses feed but thought this was overflow from her bore. The creek was almost impossible to see and follow on this property.
Henley St Henley Brook	Resident 21	Phone call on 8/10/2018	Landholders used to have part of Saint Leonards Creek on their property, but when the nearby area was developed the creek was diverted around the edge of their property.

Proposed development area in Henley Brook			
Street and suburb	**Reference**	**Method and date of discussion**	**Discussion details**
Henley St Henley Brook	Resident 22	Phone call on 30/10/2018 and met during assessment on 1/3/2019	Landholder bought the property in 1999 and wanted to grow vegies and fruit trees. A seismologist checked for water supply but didn't find water in the testing holes. The landholder then installed a deep dam lined with plastic. His neighbours have told him the Morgan Fields development changed the water supply. He has dead and dying Cypress and other trees on his block that he thinks is due to a lack of water.
Henley St Henley Brook	Resident 23	Phone call on 26/2/2019	Landholder has lived on the property for over 20 years and said the creek hasn't been a creek for 20 years. It is just a drainage channel.
Park St Henley Brook	Resident 24	Phone call on 8/10/2018	Landholder said water has been very low or none since Ellenbrook was built and Water Corporation put in testing bores. She has planted several native trees.

Appendix 3 Landholder information sheet example

Saint Leonards Creek: What's in your backyard?

Saint Leonards Creek is a seasonal tributary to the Swan River. It is approximately 27km in length, with several branches that extend into West Swan, Henley Brook and Brabham in the City of Swan.

The creek is one of ten priority tributaries the Department of Biodiversity, Conservation and Attractions (DBCA) are focusing on to improve water quality entering the Swan Canning river system.

DBCA and the City of Swan carried out a survey of the health and condition of Saint Leonards Creek in 2018 and 2019. **This is a snapshot of information collected on the creek near your property.**

Photo: ABC Open/Joanne Brazier.

Your property in November 2018

Your property was assessed on 2 November 2018. The vegetation on your property is *Juncus microcephalus* (a rush native to South Africa) over Kikuyu and other grasses and herbs.

It would have once been an open woodland of Marri, Jarrah and *Banksia* species on the upland areas and Flooded Gum and Swamp Paperbark next to the creek.

Your property is fairly low lying and the creek is quite shallow with gently sloping banks. There is a good floodplain area and we heard frogs calling near the creek.

Saint Leonards Creek would once have been home to bandicoots, rakali (native water-rat), turtles, frogs and many birds. These animals may still live in some restricted areas but are no longer found in most of the creek.

Land clearing to make way for urbanisation and other developments impacts on habitat for plants and animals, and water quality and availability. Our drying climate is also resulting in less water in creeks and rivers.

Despite this there are still beautiful places on Saint Leonards Creek that provide a refuge for nature as well as humans, and actions are being taken to protect it.

Isolepis prolifera shown on the left of the photo

Healthy vegetation on Saint Leonards Creek near Brabham Estate

What can I do to help?

If you are willing and able these are some things you could do on your property:

- Re-establish a tree canopy to cool the water and provide shade and habitat. Swamp Paperbark is a great tree to plant as they don't often drop their limbs.
- Remove *Isolepis prolifera* as it is an invasive environmental weed and can take over native plants.
- Grow native sedges and rushes to improve water quality and provide shelter for native animals.

Swamp Peppermint. APACE WA

Suggested plants to grow on your property

Your property is situated in the Southern River vegetation complex. Plants from this complex thrive best with little maintenance needed. Here are some examples of plants available at native NIASA accredited nurseries in Perth:

- Swamp Paperbark (*Melaleuca rhaphiophylla*)
- Swamp Peppermint (*Taxandria linearifolia*)
- Running Postman (*Kennedia prostrata*)
- Pale Rush (*Juncus pallidus*)

Where to go for help

City of Swan, Construction & Maintenance 9267 9267

DBCA Rivers and Estuaries Branch, Healthy Catchments program 9278 0900
www.dbca.wa.gov.au/management/swan-canning-riverpark/ecosystem-health-and-management

APACE Nursery catalogue. See plants for Southern River complex:
http://apacewa.org.au/regions/southern-river-region/

Western Weeds: A guide to the weeds of Western Australia. Book by BMJ Hussey and others

Pale rush. Westgrow

Department of **Biodiversity, Conservation and Attractions**

GOVERNMENT OF WESTERN AUSTRALIA

city of swan

Appendix 4 Dominant native species

Abbreviation	Scientific name	Common name	Section of creek: SVPA	Henley Brook	Brabham
Aca sal	*Acacia saligna*	Orange Wattle	■		■
Ade sp	*Adenanthos sp.*	Woollybush (as commonly used in landscaping)		■	
Ago fle	*Agonis flexuosa*	Peppermint	■	■	
Ani man	*Anigozanthos manglesii*	Red and Green Kangaroo Paw	■		
Ani sp	*Anigozanthos sp.*	Kangaroo Paw		■	■
Ast sco	*Astartea scoparia*	Common Astartea	■	■	■
Ban att	*Banksia attenuata*	Slender Banksia			■
Ban men	*Banksia menziesii*	Firewood Banksia	■		
Bau art	*Baumea articulata*	Jointed Rush		■	■
Bau jun	*Baumea juncea*	Bare Twigrush			■
Bau pre	*Baumea preissii*				■
Bau vag	*Baumea vaginalis*	Sheath Twigrush			■
Cal sp	*Calothamnus sp.*	One-sided Bottlebrush		■	■
Cen asi	*Centella asiatica*	Centella	■	■	■
Cor cal	*Corymbia calophylla*	Marri	■	■	■
Cor fic	*Corymbia ficifolia*	Red-flowering Gum			■
Cyc sp	*Cycnogeton huegelii or Cycnogeton lineare*	(formally Triglochin)	■		
Das bro	*Dasypogon bromeliifolius*	Pineapple Bush			■
Die ste	*Dielsia stenostachya*				■
Duckweed	*Landoltia punctata or Lemna disperma*	Thin Duckweed (*L. punctata*) or Duckweed (*L. disperma*)	■		
Ere gla	*Eremophila glabra*	Tar Bush			■
Ere sp	*Eremophila sp.*	Emu Bush			■
Euc cam	*Eucalyptus camaldulensis*	River Gum	■		
Euc ery	*Eucalyptus erythrocorys*	Illyarrie		■	
Euc gom	*Eucalyptus gomphocephala*	Tuart		■	
Euc mar	*Eucalyptus marginata*	Jarrah	■		■
Euc rud	*Eucalyptus rudis*	Flooded gum	■	■	
Fic nod	*Ficinia nodosa*	Knotted Club Rush		■	■
Gom sp	*Gompholobium sp.*		■		
Gre sp	*Grevillea sp.*	Landscaping variety			■
Gre cri	*Grevillea crithmifolia*				■
Hak pro	*Hakea prostrata*	Harsh hakea	■		
Har com	*Hardenbergia comptoniana*	Native Wisteria	■		
Hem pun	*Hemiandra pungens*	Snakebush			■
Hem unc	*Hemarthria uncinata*	Matgrass			■
Hyp ang	*Hypocalymma angustifolium*	White Myrtle			■
Iso cyp	*Isolepis cyperoides*		■		

Jac ste	*Jacksonia sternbergiana*	Stinkwood
Jun kra	*Juncus kraussii*	Sea Rush
Jun pal	*Juncus pallidus*	Pale Rush
Jun pau	*Juncus pauciflorus*	Loose Flower Rush
Ken pro	*Kennedia prostrata*	Running postman
Lep lon	*Lepidosperma longitudinale*	
Lob anc	*Lobelia anceps*	Angled Lobelia
Lob sp	*Lobelia sp.*	
Lom sp	*Lomandra sp.*	
Mel lat	*Melaleuca lateritia*	Robin Redbreast Bush
Mel pre	*Melaleuca preissiana*	Moonah or Modong
Mel rha	*Melaleuca rhaphiophylla*	Swamp paperbark
Mel sp	*Melaleuca sp.*	Melaleuca, possibly *M. viminea*
Mel thy	*Melaleuca thymoides*	
Mel vim	*Melaleuca viminea*	Mohan
Mes sp	*Mesomelaena sp.*	Semaphore Sedge
Mic sti	*Microlaena stipoides*	Weeping Grass
Pte esc	*Pteridium esculentum*	Bracken
Pti pol	*Ptilotus polystachyus*	Prince of Wales Feather
Sca sp	*Scaevola sp.*	Scaevola (as commonly used in landscaping)
Sch tab	*Schoenoplectus tabernaemontani*	
Sti lat	*Stirlingia latifolia*	Blueboy
Tax lin	*Taxandria linearifolia*	Swamp Peppermint
Tri ela	*Tricoryne elatior*	Yellow Autumn Lily
Typ sp*	*Typha domingensis or T. orientalis*	Bulrush
Wes sp	*Westringia sp.*	Westringia (as commonly used in landscaping)
Xan bru	*Xanthorrhoea brunonis*	Grass tree
Xan pre	*Xanthorrhoea preissii*	Balga

Appendix 5 Weed species sighted

Abbreviation	Scientific name	Common name	Section of creek: SVA	Henley Brook	Brabham
Aca ite	*Acacia iteaphylla*	Flinders Range Wattle	■		
Aca lon	*Acacia longifolia*	Sydney Golden Wattle			■
Aca sp ES	*Acacia sp.*	Other acacias originating from Australian Eastern States	■	■	
Aga pra	*Agapanthus praecox*	Agapanthus	■	■	
Air sp	*Aira sp.*	Hairgrasses	■	■	■
Alo arb	*Aloe arborescens*	Candelabra aloe, Krantz aloe	■		
Arc cal	*Arctotheca calendula*	Cape Weed	■	■	■
Aru don	*Arundo donax*	Giant Reed	■		
Asp asp	*Asparagus asparagoides*	Bridal Creeper	■		■
Ave bar	*Avena barbata*	Bearded Oat	■	■	■
Ave fat	*Avena fatua*	Wild Oat	■		■
Ave sp	*Avena sp.*	Oat			■
Bac mon	*Bacopa monnieri*	Bacopa			■
Bri max	*Briza maxima*	Blowfly Grass	■	■	■
Bri min	*Briza minor*	Shivery Grass	■		■
Bro dia	*Bromus diandrus*	Great Brome	■	■	■
Bro hor	*Bromus hordeaceus*	Soft Brome	■		
Cal sp ES	*Callistemon sp.*	Bottlebrush originating from Australian Eastern States		■	
Can sp	*Canna sp.*	Canna Lily (hybrid)	■		
Car edu	*Carpobrotus edulis*	Pigface, Hottentot fig			■
Cas sp	*Casuarina sp.*	Sheoaks not local to this area	■	■	
Cen cla	*Cenchrus clandestinus*	Kikuyu Grass	■		■
Cen set	*Cenchrus setaceus*	Fountain Grass		■	
Cha pal	*Chamaecytisus palmensis*	Tagasaste, tree lucerne		■	
Cir vul	*Cirsium vulgare*	Spear Thistle			■
Cit ama	*Citrullus amarus*	Wild Melon		■	■
Citrus trees	*Citrus sp.*	Citrus Trees		■	
Col esc	*Colocasia esculenta*	Taro	■		
Con sp	*Conyza sp.*	Fleabane	■	■	■
Cor sel	*Cortaderia selloana*	Pampas Grass	■		■
Cot cor	*Cotula coronopifolia*	Waterbuttons	■		■
Cot sp	*Cotula sp.*		■		
Cot tur	*Cotula turbinata*	Funnel Weed	■		■
Cya coo	*Cyathea cooperi*	Rough tree fern			■
Cyn dac	*Cynodon dactylon*	Couch Grass	■	■	■
Cyp sp	*Cyperus sp.*	Nutgrass	■	■	■
Deciduous trees				■	■
Dis bra	*Disa bracteata*	South African Orchid	■		■
Dit gra	*Dittrichia graveolens*	Stinkwort			■
Ech pla	*Echium plantagineum*	Paterson's curse	■		
Ehr cal	*Ehrharta calycina*	Perennial Veldt Grass	■	■	■
Era cur	*Eragrostis curvula*	African Lovegrass	■	■	
Euc sp ES	*Eucalyptus sp.*	Eucalypts originating from Australian Eastern States	■	■	■
Eup ter	*Euphorbia terracina*	Geraldton Carnation Weed	■	■	■
Fer cri	*Ferraria crispa*	Black Flag	■		

Abbreviation	Scientific name	Common name	Section of creek: SVA	Henley Brook	Brabham
Fic car	*Ficus carica*	Common Fig	■		■
Fic sp	*Ficus sp.*	Other Fig species		■	
Fruit trees					
Fum cap	*Fumaria capreolata*	Whiteflower Fumitory	■	■	
Garden palms				■	
Gaz sp	*Gazania sp.*	Gazania		■	
Gla sp	*Gladiolus sp.*	Gladiolus	■		■
Gom fru	*Gomphocarpus fruticosus*	Narrow-leaf Cotton Bush	■		■
Hol lan	*Holcus lanatus*	Yorkshire Fog	■	■	■
Hol sp	*Holcus sp.*	Fog Grass	■		■
Hyp sp	*Hypochaeris sp.*	Smooth Cats-ear, Flatweed	■	■	■
Ipo sp	*Ipomoea sp.*	Morning glory	■		
Iso pro	*Isolepis prolifera*	Budding Club-rush	■		■
Jac mim	*Jacaranda mimosifolia*	Jacaranda			■
Jun mic	*Juncus microcephalus*		■	■	■
Lac ser	*Lactuca serriola*	Prickly Lettuce	■	■	
Lan cam	*Lantana camara*	Common Lantana	■		■
Lan sp	*Lantana sp.*	Lantana cultivar, possibly sterile variant		■	
Lep lae	*Leptospermum laevigatum*	Coast Teatree	■		
Log gal	*Logfia gallica*	Slender Cudweed			■
Lol rig	*Lolium rigidum*	Annual Ryegrass	■		■
Lol sp	*Lolium sp.*	Ryegrass	■	■	■
Lot sp	*Lotus sp.*	Birdsfoot Trefoil	■	■	■
Lup cos	*Lupinus cosentinii*	Western Australian Blue Lupin	■		■
Lup lut	*Lupinus luteus*	Yellow Lupin	■		
Lup sp	*Lupinus sp.*	Lupin	■		
Lys arv	*Lysimachia arvensis*	Pimpernel		■	
Lyt hys	*Lythrum hyssopifolia*	Lesser Loosestrife	■		
Med pol	*Medicago polymorpha*	Burr Medic	■	■	■
Mel qui	*Melaleuca quinquenervia*	Broad-leaved Paperbark	■	■	■
Men sp	*Mentha sp.*	Mint			■
Mon bra		Segment 57			■
Mor fla	*Moraea flaccida*	One-leaf Cape Tulip	■		■
Oen mol	*Oenothera mollissima*	Evening Primrose			■
Oen sp	*Oenothera sp.*	Evening Primrose		■	
Ole eur	*Olea europaea*	Olive	■	■	
Oro min	*Orobanche minor*	Lesser Broomrape	■	■	■
Ost eck	*Osteospermum ecklonis*	Veldt Daisy		■	
Oxa pes	*Oxalis pes-caprae*	Soursob	■		
Pas fil	*Passiflora filamentosa*	Passion Flower	■		
Pas sp	*Paspalum sp.*		■	■	■
Pel cap	*Pelargonium capitatum*	Rose Pelargonium	■		
Per ame	*Persea americana*	Avocado (tree)		■	
Per sp	*Persicaria sp.*	Knotweed	■		■
Pho dac	*Phoenix dactylifera*	Date Palm	■		■
Phy oct	*Phytolacca octandra*	Inkweed, Red Ink Plant	■		■
Phy sp	*Phyllostachys sp.*	Bamboo	■		

Abbreviation	Scientific name	Common name	Section of creek: SVA	Henley Brook	Brabham
Phys sp	*Physalis sp.*	Cape Gooseberry, Chinese Lantern			
Pin sp	*Pinus sp.*	Pine (tree)			
Pla sp	*Platanus sp.*	Plane Tree, English Plane Tree			
Plan sp	*Plantago sp.*	English Plantain, Narrow-Leaved Plantain, Lamb's Tongue, Plantain			
Planted exotic trees					
Pol mar	*Polypogon maritimus*	Coast Beardgrass			
Pol sp	*Polypogon sp.*	Beardgrass			
Ran mur	*Ranunculus muricatus*	Sharp Buttercup			
Rap rap	*Raphanus raphanistrum*	Wild Radish			
Ric com	*Ricinus communis*	Castor Oil Plant			
Ror aqu	*Rorippa nasturtium-aquaticum*	Watercress			
Ros DP	*Rosa Dorothy Perkins*	Dorothy Perkins Climbing Rose			
Ros off	*Rosmarinus officinalis*	Rosemary			
Rub sp	*Rubus sp.*	Blackberry			
Rum ace	*Rumex acetosella*	Sorrel			
Rum cri	*Rumex crispus*	Curled Dock			
Rum sp	*Rumex sp.*	Dock			
Sal bab	*Salix babylonica*	Weeping Willow			
Sch ter	*Schinus terebinthifolia*	Brazilian Pepper Tree			
Sol lin	*Solanum linnaeanum*	Apple of Sodom			
Sol nig	*Solanum nigrum*	Black Berry Nightshade			
Son sp	*Sonchus sp.*	Sowthistle			
Ste sec	*Stenotaphrum secundatum*	Buffalo Grass			
Str reg	*Strelitzia reginae*	Bird of Paradise			
Tri arv	*Trifolium arvense*	Hare's Foot Clover			
Tri dub	*Trifolium dubium*	Suckling Clover			
Tri rep	*Trifolium repens*	White Clover			
Tri sp	*Trifolium sp.*	Clover			
Tro maj	*Tropaeolum majus*	Nasturtium			
Typ sp.*	*Typha sp.**	Bulrush*			
Urs ant	*Ursinia anthemoides*	Ursinia			
Ver enc	*Verbesina encelioides*	Golden Crownbeard			
Vic sat	*Vicia sativa*	Common Vetch			
Vic sp	*Vicia sp.*	Vetch			
Vit vin	*Vitis vinifera*	European Wine Grape, Common Grape			
Vul sp	*Vulpia sp.*	Fescue (grass)			
Wah cap	*Wahlenbergia capensis*	Cape Bluebell			
Was fil	*Washingtonia filifera*	Cotton Palm			
Wat sp	*Watsonia sp.*	Watsonia			
Zan aet	*Zantedeschia aethiopica*	Arum lily			

**Typha domingensis* and *Typha orientalis* are considered native to WA, but they may act as environmental weeds.

Appendix 6 Water quality data from North Metro TAFE

Site	Monitoring Date	pH (Av.)	Cond. uS/cm (Av.)	Temp. ºC (Av.)	DO% (Av.)	DO mg/L	SPC uS/cm	Turbidity NTU	Oxidation Reduction Potential	Mean *E. coli* mpb /100mL
1A	20/02/19	7.17	633	20.7	51.8	3.57	660	49.7	-20.7	
	06/03/19	7.54	710	18.4	47.7	4.42	753		-68.6	
	08/05/19	7.35	1078	16.5	54.1	5.10	1275		-65.3	
	29/05/19	6.89	954	13.4	39.4	4.06	1077			25.4
1B	20/02/19	7.43	688	24.0	89.3	6.50	689	60.5	-38.2	
	06/03/19	7.53	744	18.1	113.8	10.50	790		-51.3	
	08/05/19									
	29/05/19									25.4
2	20/02/19	7.20	789	21.7	52.5	3.6	826	81.3	-28.0	
	06/03/19	7.78	1420	17.8	55.6	3.33	1533		-64.8	
	08/05/19	7.25	838	15.5	72.9	5.36	920		-65.3	
	29/05/19	6.80	528	13.7	32.5	3.4	561			165.2
3	20/02/19	7.34	483	31.4	118.5	7.06	464	12.2	-81.3	
	06/03/19	7.02	415	22.6	36.6	3.33	403			
	08/05/19	7.38	343	22.1	70.1	5.93	361.6			
	29/05/19	7.09	330	13.7	69.0	4.82	398		-53.6	200.5
4	20/02/19	7.16	511	27.8	58.2	3.65	503	2.82	-39.1	
	06/03/19	7.36	503	21.5	48.0	3.14	550		-58.3	
	08/05/19	7.19	433	17.5	83.5	6.63	471		-58.2	
	29/05/19	6.58	412	31.1	60.7	6.63	461			94.5
7	20/02/19	8.07	3776	28.8	85.2	5.00	3636	221	-77.4	

Site	Monitoring Date	pH (Av.)	Cond. uS/cm (Av.)	Temp. ºC (Av.)	DO% (Av.)	DO mg/L	SPC uS/cm	Turbidity NTU	Oxidation Reduction Potential	Mean *E. coli* mpb /100mL
	06/03/19	7.98	4200	22.6	69.3	5.66	4293			
	08/05/19	8.66	7767	26.2	202.1	15.88	7764			
	29/05/19	7.70	8860		19.1					200.5

**ANZECC Guidelines 2000, South-West Australia Water Quality Readings for Lakes, reservoirs and wetlands

Parameter	Low value	High value
pH	6.5	8
Salinity (uS/cm)	300	1500
Dissolved Oxygen (DO) % saturation	90	
Turbidity (NTU)	10	100
Bacteria (*E. coli*) mpb/100mL for recreational waters		100

Appendix 7 Sediment analysis data from North Metro TAFE

Soil samples of 2g (± 0.5g) in 100mL of water.

Site number	Sample Id	Cu 327 (ppm)	Cu 324 (ppm)	Pb 220 (ppm)	Zn 213 (ppm)	Cd 214 (ppm)
Site 1	JSIA-1	6.913	6.362	-0.024	61.016	0.209
Site 1	JSIA-1 DUP	6.027	5.678	-0.495	61.308	0.196
Site 1	JSIA-2	6.101	5.560	-0.009	34.548	0.225
Site 1	RSIB-1	11.091	10.871	9.270	22.311	0.375
Site 1	RSIB-2	10.820	11.171	5.692	46.279	0.187
Site 2	MS2-1	7.517	6.496	12.453	22.526	0.495
Site 2	MS2-1 DUP	5.395	4.433	12.083	23.654	0.602
Site 2	MS2-2	6.142	4.886	13.913	25.625	0.846
Site 3	ZS3-1	3.507	3.162	2.287	12.751	0.043
Site 3	ZS3-1 DUP	5.596	5.312	2.360	12.814	0.065
Site 4	TS4-1	3.633	3.140	0.968	*22.22*	0.223
Site 4	TS4-1 DUP	3.124	2.537	0.571	9.092	0.083
Site 4	TS4-2	6.041	5.488	0.268	13.341	0.057
Site 5	GS5-1	20.995	19.676	2.855	15.907	0.758
Site 5	GS5-2	11.310	10.558	-0.461	17.515	0.058
Site 6	GS6-1	12.093	8.262	5.303	52.374	1.951
Site 6	GS6-1 DUP	14.983	10.872	5.851	55.515	2.379
Site 6	GS6-2	19.902	12.493	5.393	60.935	4.794
Site 7	GS7-1	14.660	13.613	3.438	58.695	0.855
Site 7	GS7-1 DUP	17.279	15.258	2.784	56.000	1.009
Site 7	GS7-2	29.594	24.014	8.979	140.091	3.162
Site 7	GS7-2 DUP	27.827	22.838	10.159	138.681	2.978
Site 8	MS8-1	22.998	15.904	17.027	66.182	3.568

Yellow highlighting indicates that values have exceeded the Low ANZECC value but are within acceptable limits. Green highlighting indicates that values are approaching the Low ANZECC value. Unhighlighted values are well below the Low ANZECC value.

Table 5: ANZECC Guidelines 2000 (page 3.5-4 Table 3.5.1) Recommended Sediment Quality Guidelines

Metal	Low (ppm)	High (ppm)
Copper (Cu)	65	270
Lead (Pb)	50	220
Zinc (Zn)	200	410
Cadmium (Cd)	1.5	10

Appendix 8 Pen and Scott foreshore condition rating

(Pen and Scott 1995, pp.4-6)

A-Grade

Foreshore has healthy native bush, similar to that which you would see in most nature reserves, state forests and national parks.

A1. Pristine	The river embankments and floodway are entirely vegetated with native species and there is no evidence of human presence or livestock damage.
A2. Near pristine	Native vegetation dominates. Some introduced weeds may be present in the understorey but not to the extent that they displace native species. Otherwise there is no evidence of human impact.
A3. Slightly disturbed	Native vegetation dominates, but there are some areas of human disturbance where soil may be exposed and weeds are relatively dense (such as along tracks). The native vegetation would quickly recolonise if human disturbance declined.

B-Grade

The bush along the stream has been invaded by weeds, mainly grasses, and looks like typical roadside bush.

B1. Degraded – weed infested	Weeds have become a significant component of the understorey vegetation. Although native species are dominant, a few have been replaced by weeds.
B2. Degraded - heavily weed infested	In the understorey, weeds are about as abundant as native species. The regeneration of some tree and large shrub species may have declined or disappeared altogether.
B3. Degraded – weed dominated	Weeds dominate the understorey, but many native species remain. Some trees and large shrub species may have declined or disappeared altogether.

C-Grade

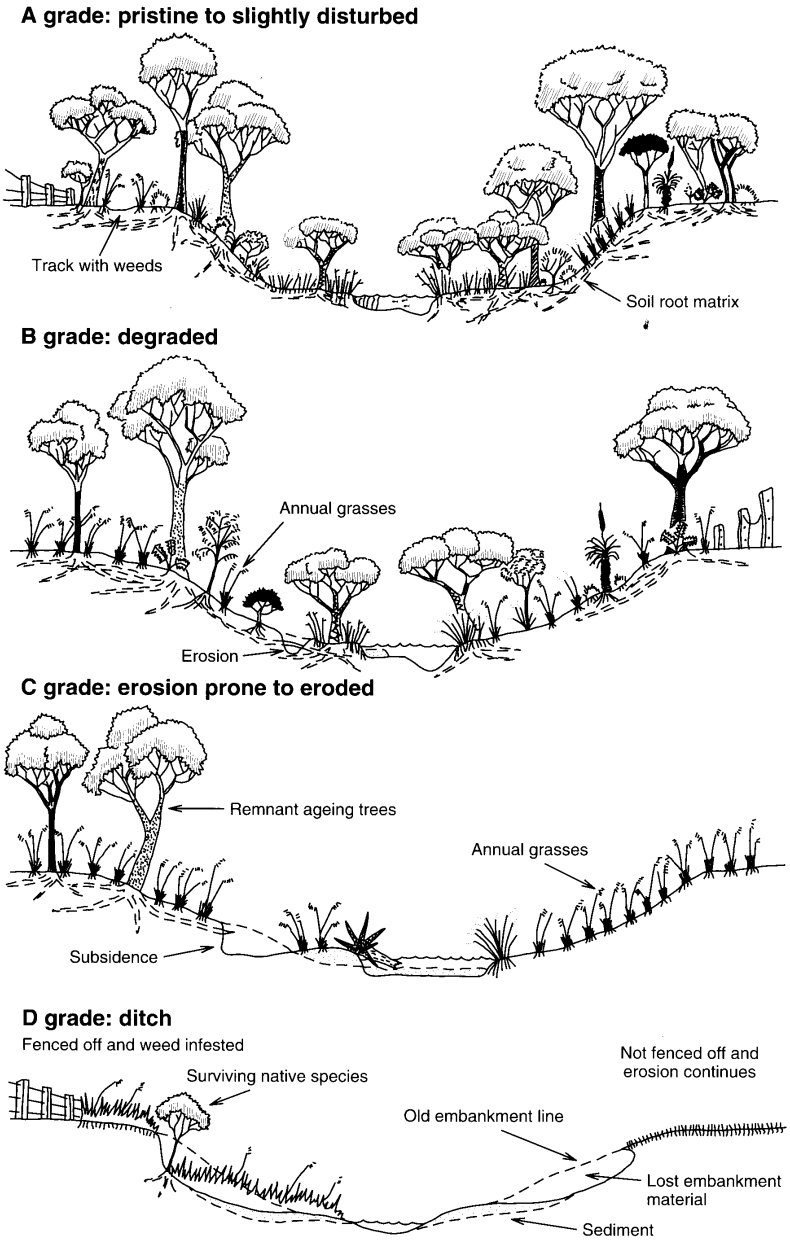
The foreshore supports only trees over weeds or pasture, or just plain pasture, and bank erosion and subsidence may be occurring but only in a few spots.

C1. Erosion prone	Trees remain, and possibly some large shrubs or grasses, but the understorey consists entirely of weeds, mainly annual grasses. The trees are generally resilient or long-lived species but there is little or no evidence of regeneration. The shallow-rooted weedy understorey provides no support to the soil, and only a small increase in physical disturbance will expose the soil and make the river embankments and floodway vulnerable to erosion.
C2. Soil exposed	Older trees remain, but the ground is virtually bare. Annual grasses and other weeds have been removed by livestock trampling or grazing, or through overuse by humans. Low-level soil erosion has begun, by the action of either wind or water.
C3. Eroded	Soil is washed away from between tree roots, trees are being undermined and unsupported embankments are subsiding into the river valley.

D-Grade

The stream is little more than an eroding ditch or a weed infested drain.

D1. Ditch - eroding	There is not enough fringing vegetation to control erosion. Some trees and shrubs remain and act to retard erosion in certain spots, but are doomed to be undermined eventually.
D2. Ditch – freely eroding	No significant fringing vegetation remains and erosion is completely out of control. Undermined and subsided embankments are common, and large sediment plumes are visible along the river channel.
D3. Drain – weed dominated	The highly eroded river valley has been fenced off, preventing control of weeds by stock. Perennial weeds have become established. The river has become a simple drain, similar or identical to a typical major urban drain.



Appendix 9 Parameters used for the categorisation of river segments

Rarity or conservation value

Conservation value was determined from the desktop assessment and the proximity of segments to recognised natural and cultural assets.

Condition

The Pen and Scott grades were summarised into an overall good, average or poor condition rating for each segment for the purpose of categorisation.

- Good – A1, A2, A3
- Average – B1, B2, B3, C1 or C2
- Poor – C3, D1, D2 or D3

Trajectory and Hope

The trajectory of each segment was determined in the field.

- A segment was considered stable/improving if it was actively managed or there were few signs of pressures and threats, and vegetation was in a relatively undisturbed state.
- A segment was determined to be deteriorating if active erosion was present, no active management was occurring, or active management was not successful, vegetation condition was average to poor and exotic species regeneration was characteristic of the segment.

Deteriorating segments were prioritised above those which were stable/improving as it is considered more efficient to stabilise deteriorating segments, rather than remediating them later (Rutherfurd et al. 2000b).

Segments in poor condition were divided into those **without hope**, segments which would not recover without intervention; and those **with hope**, improving reaches which may eventually recover naturally (Rutherfurd et al. 2000b). Segments without hope are given slightly higher priority than those with hope, as the latter have a smaller chance of recovering independently over time.

Proximity to good segments

Rutherfurd et al. (2000b) explain it is more effective to expand an area which is already in good condition or being rehabilitated, rather than work on an isolated stretch adjacent to segments in poor condition. This increases the length of the stream community and provides a source of flora and fauna to colonise the newly rehabilitated reach.

In order of priority, Rutherfurd et al. (2000b) recommend working on:

1. Segments with a mix of high-quality assets and some degraded assets;
2. Poor quality segments that link two segments in good condition;

3. Poor quality segments connected by one end to a segment in good condition, then
4. Poor quality segments that are distant from good quality segments.

After the overall condition rating was applied, location of segments in relation to condition were identified using GIS, then ranked based on their proximity to good condition segments.

Ease of rehabilitation

Ease of rehabilitation was determined in the field.

- Segments that were deemed ‘easy’ to rehabilitate were those that were in good condition, with a good vegetation structure and complexity remaining, where weeds were not dominant, and where all that may be needed is short-term weed control and infill planting.
- Segments that were deemed ‘hard’ to rehabilitate were those where native vegetation structure and complexity was largely lost, and which had extensive weed cover, or where erosion was occurring at multiple points along the reach. Rehabilitation required would be wide scale and need to occur over many years to make a long-lasting impact.

Segments were assigned a category value from 0 to 8. Several modifications were made to the process that had been carried out by the Swan River Trust in 2008:

- the buffer width for conservation value was increased from 20m to 500m;
- national parks were not included in the criteria for conservation value, as it is not relevant to Bennett Brook and to be consistent with the 2017 categorisation of the Helena River;
- Environmentally Sensitive Areas were added to the criteria for conservation value;
- the level of pressure was determined in the field and included landscape disturbances such as adjacent intensive land uses, dams and modifications to the river alignment, not only the erosion, grazing and trampling issues noted in the segment;
- bank stability was considered independently of weed coverage (e.g. if no or little erosion was sighted and the banks appeared stable, despite the understorey being weedy, stability was considered ‘good’), rather than using the vegetation condition score and presence or absence of vegetation trampling; and
- trajectory, hope and ease of rehabilitation were determined in the field rather than a combination of bank stability, vegetation condition and pressure scores.

Appendix 10 Matrix for the categorisation of river segments

Adapted from Cooperative Research Centre (CRC) for Catchment Hydrology (Rutherfurd et al. 2000)

ID segments with high conservation value assets	Pen & Scott = A1 Pressures = Minimal No threats or ideas for management	Intersection with known values Pen & Scott = A1, A2,or A3	Pen & Scott = A1, A2,or A3											
Sort according to condition	Good (Pen & Scott = A1, A2 or A3)			Average (Pen & Scott = B1, B2, B3, C1 or C2)						Poor (Pen & Scott = C3, D1, D2 or D3)				
Sort according to trajectory				(Trajectory = Deteriorating)		(Trajectory = Stable – Improving)				(Hope = Without hope)		(Hope = With hope)		
Sort according to proximity to good segments				(Close) Adjacent segment P&S =A1,A2,A3	(Distant) Adjacent segment P&S ≠A1,A2,A3	(Close) Adjacent segment P&S =A1,A2,A3		(Distant) Adjacent segment P&S ≠A1,A2,A3		(Close) Adjacent segment P&S =A1,A2,A3	(Distant) Adjacent segment P&S ≠A1,A2,A3	(Close) Adjacent segment P&S =A1,A2,A3	(Distant) Adjacent segment P&S ≠A1,A2,A3	
Sort according to ease				(Easy)	(Hard)	(Easy)	(Hard)	(Easy)	(Hard)	(Easy)	(Hard)	(Easy)	(Hard)	
Priority category	**0**	**1**	**2**	**3**		**4**	**5**	**6**		**7**		**8**		
	Segments in good condition throughout, that are already protected	Protect regional conservation value segments	Protect local conservation value segments	Protect and improve deteriorating segments		Expand good segments	Improve impeded recovery segments (easily fixed segments)	Improve moderately damaged segments (more difficult to fix)		Improve poor segments		Improve poor segments with hope		

Appendix 11 Description of attributes in Saint Leonards assessment shapefile

Attribute	Description
OBJECTID *	Automatically generated unique identifier (within shapefile)
Shape *	Automatically generated geometric coordinates (within shapefile)
Date	Date the segment was assessed
OFFICER	Initials of the field officers who assessed the segment
RIVER	Name of tributary being assessed
SUMM_COMM	Summary comment; additional observations related to the segment not included elsewhere
WEED_SP	Weed species; a complete list of all weeds sighted on the segment
NATIVE_SP	Dominant native species; a list of the dominant native species from any stratum noted in the segment
ERO_SILT_L	Erosion and siltation, Left Bank; whether erosion and siltation pose a management issue
ERO_SILT_R	Erosion and siltation, Right Bank; whether erosion and siltation pose a management issue
ERO_UNDER	Erosion, Undermining; whether undermining is present
ERO_DEPOS	Erosion, Large deposits; whether large deposits are present
ERO_SCOUR	Erosion, Incised scour; whether incised scours are present
ERO_SLUMP	Erosion, Slumped bank; whether slumped banks are present
ERO_RETREA	Erosion, Embayment retreat; whether embayment retreat is present
ERO_EXPOSE	Erosion, Exposed tree roots; whether exposed tree/shrub roots are present
VEG_TRAMP	Vegetation loss, Trampling; whether there is loss of native riparian vegetation through trampling by humans or livestock

Attribute	Description
VEG_GRAZE	Vegetation loss, Grazing; whether there is loss of native riparian vegetation through grazing, including evident historic grazing (note in Mgt Issues Comment that it is historic)
VEG_WEEDS	Vegetation loss, Displacement by weeds; whether there is loss of native vegetation through displacement by weeds
VEG_CLEAR	Vegetation loss, Clearing; whether there is loss of native vegetation through clearing, including evident historic clearing (note in Mgt Issues Comment that it is historic)
VEG_ERO	Vegetation loss, Erosion; whether there is loss of native vegetation through erosion, including evident historic erosion (note in Mgt Issues Comment that it is historic)
VEG_VEHICL	Access, Vehicles; evidence of access by vehicles off marked tracks
ACC_PEOPLE	Access, People; evidence of access by people off marked tracks and trails
ACC_STOCK	Access, Stock; evidence of uncontrolled stock access
ACC_OTH_L	Access, Other, Left Bank; indicates access by something else to the left bank
ACC_OTH_R	Access, Other, Right Bank; indicates access by something else to the right bank
MGT_COMM	Management Issues Comment; any additional information to record on any of the above
BANK_SLP_L	Slope of bank, Left Bank; the average bank slope in three categories: gentle, medium or steep
BANK_SLP_R	Slope of bank, Right Bank; the average bank slope in three categories: gentle, medium or steep
BANK_HGT_L	Height of bank, Left Bank; The average height of the bank in metres, from water level to the top of the immediate bank
BANK_HGT_R	Height of bank, Right Bank; The average height of the bank in metres, from water level to the top of the immediate bank
FENCING	Fencing; whether fencing is present along the riparian zone preventing access by humans or livestock

Attribute	Description
LU_AGRIC	Agricultural; whether the land surrounding the segment is used for agriculture
LU_PARK	Parkland; whether the land surrounding the segment is used for parkland
LU_RURAL	Rural; whether the land surrounding the segment is used for rural purposes
LU_RESI	Residential; whether the land surrounding the segment is used for residential purposes
LU_COMM	Commercial/ industrial; whether the land surrounding the segment is used for commercial/ industrial purposes
LU_BUSH	Remnant bushland/ reserve; whether the land surrounding the segment is used for remnant bushland/ reserve
LU_REC	Recreation; whether the land surrounding the segment is used for recreation, ie walking/running trails or exercise infrastructure is in place
CON_VEG_L	Vegetation, Left Bank; Vegetation condition (ie % cover of natives compared to weeds, native regeneration, crown death etc)
CON_VEG_R	Vegetation, Right Bank; Vegetation condition (ie % cover of natives compared to weeds, native regeneration, crown death etc)
CON_WEED_L	Weed cover, Left Bank; weed cover (ie no or low weed % cover=Minimal to weed dominated=Extensive)
CON_WEED_R	Weed cover, Right Bank; weed cover (ie no or low weed % cover=Minimal to weed dominated=Extensive)
CON_BANK_L	Bank stability, erosion, Left Bank; the stability of the bank (this may not be visible if veg cover is very high & in many cases stability will then be good)
CON_BANK_R	Bank stability, erosion, Right Bank; the stability of the bank (this may not be visible if veg cover is very high & in many cases stability will then be good)

Attribute	Description
PRESSURE_L	Pressures, Left Bank; Level of pressure (such as pressure from adjacent land uses, dams, weed infestations, uncontrolled stock or human access etc) on a segment
PRESSURE_R	Pressures, Right Bank; Level of pressure (such as pressure from adjacent land uses, dams, weed infestations, uncontrolled stock or human access etc) on a segment
TRAJECT_L	Trajectory, Left Bank; whether a segment is stable/ improving or deteriorating in condition based on the current level of management
TRAJECT_R	Trajectory, Right Bank; whether a segment is stable/ improving or deteriorating in condition based on the current level of management
TRA_W_MGT	Positive trajectory: Weed management; whether weed management is evident and contributing to an improvement in condition
TRA_REVEG	Positive trajectory: Revegetation; whether revegetation is evident and contributing to an improvement in condition
TRA_REGEN	Positive trajectory: Native species regeneration; whether regeneration is evident and contributing to an improvement in condition
TRA_ACCESS	Positive trajectory: Controlled access; whether access by vehicles, people or stock is controlled and contributing to an improvement in condition
TRA_RIFFLE	Positive trajectory: Riffles; whether riffles have been installed or are naturally occurring and contributing to an improvement in condition
TRA_WEED	Negative trajectory: Exotic species regeneration; whether regeneration is evident and contributing to a decline in condition
TRA_ERO	Negative trajectory: Active erosion; whether erosion is evident and contributing to a decline in condition
TRA_LOSS	Negative trajectory: Loss of native vegetation; whether loss of vegetation is evident and contributing to a decline in condition

Attribute	Description
HOPE_L	Hope, Left Bank; whether a segment can improve on its own or if it needs human intervention
HOPE_R	Hope, Right Bank; whether a segment can improve on its own or if it needs human intervention
EASE_L	Rehab, Left Bank; whether a segment would be easy (little work required, low cost) or difficult (large amount of ongoing work required, high cost) to rehabilitate
EASE_R	Rehab, Right Bank; whether a segment would be easy (little work required, low cost) or difficult (large amount of ongoing work required, high cost) to rehabilitate
REHAB_ACC	Access; an attribute which tells us if we think the segment would be easy to rehabilitate, based on accessibility of the segment (eg vegetation density, steepness of slope, private land etc) (value in attribute table=easy; no value=hard)
REHAB_CON	Condition of native vegetation; an attribute which tells us if we think the segment would be easy to rehabilitate, based on condition of native vegetation (eg healthy with potentially high regeneration or sickly with poor potential for native regeneration) (value in attribute table=easy; no value=hard)
REHAB_WEED	Weed prevalence; an attribute which tells us if we think the segment would be easy to rehabilitate, based on weed prevalence (eg few weeds would make rehabilitation easier and many weeds would make it difficult to rehabilitate) (value in attribute table=easy; no value=hard)
REHAB_FENC	Fencing, Construct a fence; whether a fence needs to be constructed
REHAB_RPR	Fencing, Repair an existing fence; whether an existing fence needs repair
REHAB_RLCE	Fencing, Replace an existing fence; whether an existing fence needs to be replaced
WEED_ID	Weeds, Identify species; whether weeds need to be identified
WEED_CHEM	Weeds, Chemical treatment; whether weeds require treatment (herbicide application)

Attribute	Description
WEED_MECH	Weeds, Mechanical removal; whether weeds require mechanical removal (plant taken away)
REHAB_ERO	Erosion control; whether erosion control treatments need to be installed
REHAB_SILT	Stormwater; Silt management required; whether silt management is required. This was only filled out if high levels of sedimentation were evident
REHAB_WATR	Stormwater; Water quality management required; whether water quality management is required. This was only filled out if water quality was poor by a visual assessment, eg it was a strange colour, smelt badly, high levels of algae were present
REHAB_COMM	Rehab Comment; if any other rehabilitation techniques are required, record what they are in this comment field
S_METHOD	Survey method; whether the complete length of the segment could be accessed and assessed, or if viewing from access points only was possible
S_QUALITY	Survey quality; whether the segment could be assessed with adequate viewing, or if some or much extrapolation was needed and some features of the segment may not have been sighted and recorded
P_S_L	Pen & Scott grading, LB; condition grading using the Pen & Scott method from A1 (pristine) to D3 (ditch)
P_S_R	Pen & Scott grading, RB; condition grading using the Pen & Scott method from A1 (pristine) to D3 (ditch)
CATEGORY_L	Category, LB; the Rutherfurd matrix priority categories, ranging from protecting and conserving the good areas to improving the average to poor condition areas
CATEGORY_R	Category, RB; the Rutherfurd matrix priority categories, ranging from protecting and conserving the good areas to improving the average to poor condition areas
PRIO_COMM	Photo numbers taken of the segment
VEG_DESCRI	Vegetation description; structural description and including dominant species in the over, mid and understorey

Attribute	Description
LOCALISED_PRESSURES	Determined in the office, in the same way that the Pressures field had been completed in the 2007 assessment, considering erosion and siltation, vegetation loss and access issues that were recorded for the segment
COMPARATIVE_BANK_STABILITY	Determined in the office, in the same way that the Bank Stability field had been completed in the 2007 assessment, considering Vegetation Condition and Vegetation Loss through Trampling
COMPARATIVE_TRAJECTORY	Determined in the office, in the same way that the Trajectory field had been completed in the 2007 assessment, considering Comparative Bank Stability; Vegetation Condition and Localised Pressures
COMPARATIVE_HOPE	Determined in the office, in the same way that the Hope field had been completed in the 2007 assessment, considering Vegetation Condition, Comparative Bank Stability and Localised Pressures
COMPARATIVE_EASE	Determined in the office, in the same way that the Ease of Rehab field had been completed in the 2007 assessment, considering Vegetation Condition, Comparative Bank Stability and Localised Pressures
Shape_Length	Length of the segment in metres
SEGMENT	Sequential numbering of the segments from Mundaring Weir downstream to the Swan River
ZONE	One of three zones that the creek has been divided into for ease of reporting: *Swan Valley Planning Act* area; Henley Brook development area and Brabham development area.

References

City of Swan website https://www.swan.wa.gov.au/City-Council/About-the-organisation/Local-Area-Planning/Urban-Growth-Corridor [Accessed 22 July 2019].

Department of Biodiversity, Conservation and Attractions. 2017. *A methodology for the evaluation of wetlands on the Swan Coastal Plan, Western Australia.* Department of Biodiversity and Conservation, Perth WA.

Department of Water. 2009. *Field Sampling Guidelines: A Guideline for field sampling for surface water quality monitoring programs, standard operating procedures*. Department of Water. Perth WA.

Department of Water and Environmental Regulation. 2019. *Swan Canning Catchment Nutrient Report 2018: St Leonards Creek.* Department of Water and Environmental Regulation and Department of Biodiversity, Conservation and Attractions, Perth WA.

Department of Water and Environmental Regulation. 2018. *Technical report prepared for the Department of Biodiversity, Conservation and Attractions (Rivers and Estuaries Branch)*, September 2018, Perth, WA.

Keighery G. and McCabe S. 2015. Status of *Typha orientalis* in Western Australia. *Western Australian Naturalist*. Vol 30, pp.30-35.

Pen, L.J. and Scott, M. 1995. *Stream foreshore assessment in farming areas*. Blackwood Catchment Co-ordinating Group, Western Australia.

Pen, L.J. and Scott, M. 1999. *Planning and Management: foreshore condition assessment in farming areas of south-west Western Australia*. Report No. RR3 prepared for the Water and Rivers Commission, Western Australia.

Rutherfurd, I.D., Jerie, K. and Marsh, N. 2000a. *A Rehabilitation Manual for Australian Streams Volume 1*. Cooperative Research Centre for Catchment Hydrology, University of Melbourne, Victoria.

Rutherfurd, I.D., Jerie, K. and Marsh, N. 2000b. *A Rehabilitation Manual for Australian Streams Volume 2*. Cooperative Research Centre for Catchment Hydrology, University of Melbourne, Victoria.

Swan River Trust. 2008. *Swan Canning Tributary Foreshore Assessment Project*. CD of GIS data. Swan River Trust and Swan Catchment Council.

Swan River Trust. 2011. *Local Water Quality Improvement Plan Saint Leonards Creek Catchment.* Swan River Trust, Perth WA.