

Growling Grass Frog Crossing Design Standards

Melbourne Strategic Assessment



Cover image: A single span bridge over Kalkallo Creek provides easy passage for Growling Grass Frogs moving along the waterway corridor. Photo by Kathy Preece

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Growling Grass Frog
(*Litoria raniformis*).
Photo by Geoff Heard,
University of Melbourne





A long, narrow box culvert (opening obscured by rushes, lower right) does not provide easy passage for Growling Grass Frogs trying to move between wetlands separated by this main road. Photo by Daniel Sutton

Introduction

The Growling Grass Frog *Litoria raniformis* is listed as a threatened species under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

It was once one of the most common frogs in south-eastern Australia but has suffered a substantial decline in range and abundance in recent decades (Clemann and Gillespie 2012). Numerous threatening processes are thought to contribute to this decline. One of the most significant issues in the urban growth corridors is the barrier to Growling Grass Frog dispersal created by roads.

The Commonwealth Government has approved urban development under the Melbourne Strategic Assessment (DSEWPaC 2013) on condition that, among other things, actions are undertaken in accordance with the *Biodiversity Conservation Strategy for Melbourne's Growth Corridors* (DEPI 2013a) and *Sub-regional Species Strategy for the Growling Grass Frog* (DEPI 2013b).

The Victorian Government has committed to ensuring the persistence of the Growling Grass Frog within the Melbourne Strategic Assessment program area. The *Delivering Melbourne's newest sustainable communities Program Report* (DSE 2009), which specifies the program and identifies the processes and mitigation measures for the Melbourne Strategic Assessment program, outlines the activities to:

Maintain functioning sustainable populations of ... Growling Grass Frog within and adjacent to the growth corridors with connectivity between populations. Protect and enhance ... important populations of Growling Grass Frog that occur within the growth corridors.

The *Biodiversity Conservation Strategy for Melbourne's Growth Corridors* identified Growling Grass Frog conservation areas that must be protected and enhanced in order to achieve the conservation outcomes for Growling Grass Frog.

The *Sub-regional Species Strategy for the Growling Grass Frog* noted that:

Growling Grass Frog populations and habitats within and outside the growth corridors need to be protected and managed on a landscape level and also on a patch or population level, where frogs have the capacity to move within and between sites. The greatest opportunity to achieve this outcome is by protecting key waterways with large buffers that allow for protection and creation of additional

breeding habitat with sufficient area for foraging and dispersal between sites.

While major infrastructure is generally excluded from conservation areas, there will be instances where infrastructure crossings (such as roads, railways and utilities) are unavoidable. Building crossings through habitat creates a barrier to movement which poses a major risk to the achievement of the Growling Grass Frog conservation outcomes – particularly the need to maintain connectivity between populations.

The *Growling Grass Frog Masterplan for Melbourne's Growth Corridors* (DELWP 2017) establishes standards to provide passage for Growling Grass Frogs under crossings for roads and other infrastructure as well as habitat design standards, priority reaches for investment and mapping of Areas of Strategic Importance. This document is a key component of the Masterplan package.



Figure 1 Growling Grass Frog conservation area overview



Purpose

The *Biodiversity Conservation Strategy for Melbourne's Growth Corridors and Sub-regional Species Strategy for the Growling Grass Frog* addressed some of the threatening processes that are likely to be contributing to the decline of the Growling Grass Frog in the Melbourne growth corridors, but identified the need for further information and standards for some issues.

The purpose of the *Growling Grass Frog Crossing Design Standards* is to ensure that crossings for new and widened roads, railway lines and other infrastructure through conservation areas are designed to ensure that Growling Grass Frogs will be able to easily move through, so that metapopulation dynamics can be maintained. They will allow Growling Grass Frogs to move along the corridor, thereby minimising the impact of this infrastructure on the persistence of Growling Grass Frog populations in conservation areas under the Melbourne Strategic Assessment.

The standards are informed by the available literature on the use of various structures by amphibians within Australia and overseas, as well as observations from the greater Melbourne area.

Within the Growling Grass Frog conservation areas established under the *Biodiversity Conservation Strategy for Melbourne's Growth Corridors*, the Department of Environment, Land, Water and Planning (DELWP) will apply these standards to:

- the preparation of Conservation Area Concept Plans and Precinct Structure Plans;
- the assessment of infrastructure proposals within Growling Grass Frog conservation areas;
- the design and construction of roads, rail or other infrastructure across Growling Grass Frog conservation areas; and
- review of completed crossing projects.

The standards may be revised over time to incorporate research results and other new information including experience gained from constructing new crossings.



Urbanisation results in many new crossings over waterways. Image from Google Earth

The impact of roads on Growling Grass Frog persistence

The Growling Grass Frog was common and widespread across its range in south-eastern Australia, but declined quite suddenly from about 1990 and is now uncommon and threatened with extinction. This species displays “classical metapopulation” dynamics, in which networks of spatially discrete populations are connected by infrequent dispersal (Heard *et al.* 2012a). Within these networks, populations are prone to extinction (for example when habitat becomes unsuitable), but these extinctions may be offset by colonisation of vacant habitat patches. The probabilities of extinction and colonisation vary among habitat patches and over time.

The barrier effect of roads on amphibians is well known (Hamer *et al.* 2015, van der Ree *et al.* 2008). Research and field observations in Victoria have identified issues affecting the dispersal of Growling Grass Frogs between habitat patches, of which the barrier effect created by roads and railway crossings is considered to pose the most serious risk to the persistence of Growling Grass Frog populations in the conservation areas (Pyke 2002, Clemann and Gillespie 2012, Heard *et al.* 2012b, Heard *et al.* 2013). Hale *et al.* (2013) detected significant genetic differences between Merri Creek populations separated by urban infrastructure.

International research has shown that larger amphibians tend not to travel more than 50 metres along a barrier when seeking an opening under it (Schmidt and Zumbach 2008).

Crossings impact on the Growling Grass Frog by:

- removing habitat;
- modifying habitat (for example changes to the hydrology);
- causing injury and mortality from vehicular collisions (roadkill); and
- acting as a barrier to movement between habitat patches, thereby fragmenting populations and disrupting metapopulation function.

While box culverts or pipes are often used to convey stormwater flows under roads or railway lines, there is no conclusive research evidence that these arrangements provide easy passage for Growling Grass Frogs.

However there is one case study of a recent flooded culvert design on Edgars Creek in Melbourne’s north which demonstrated that Growling Grass Frogs (adults and tadpoles) passed under the road (Koehler and Gilmore 2014).

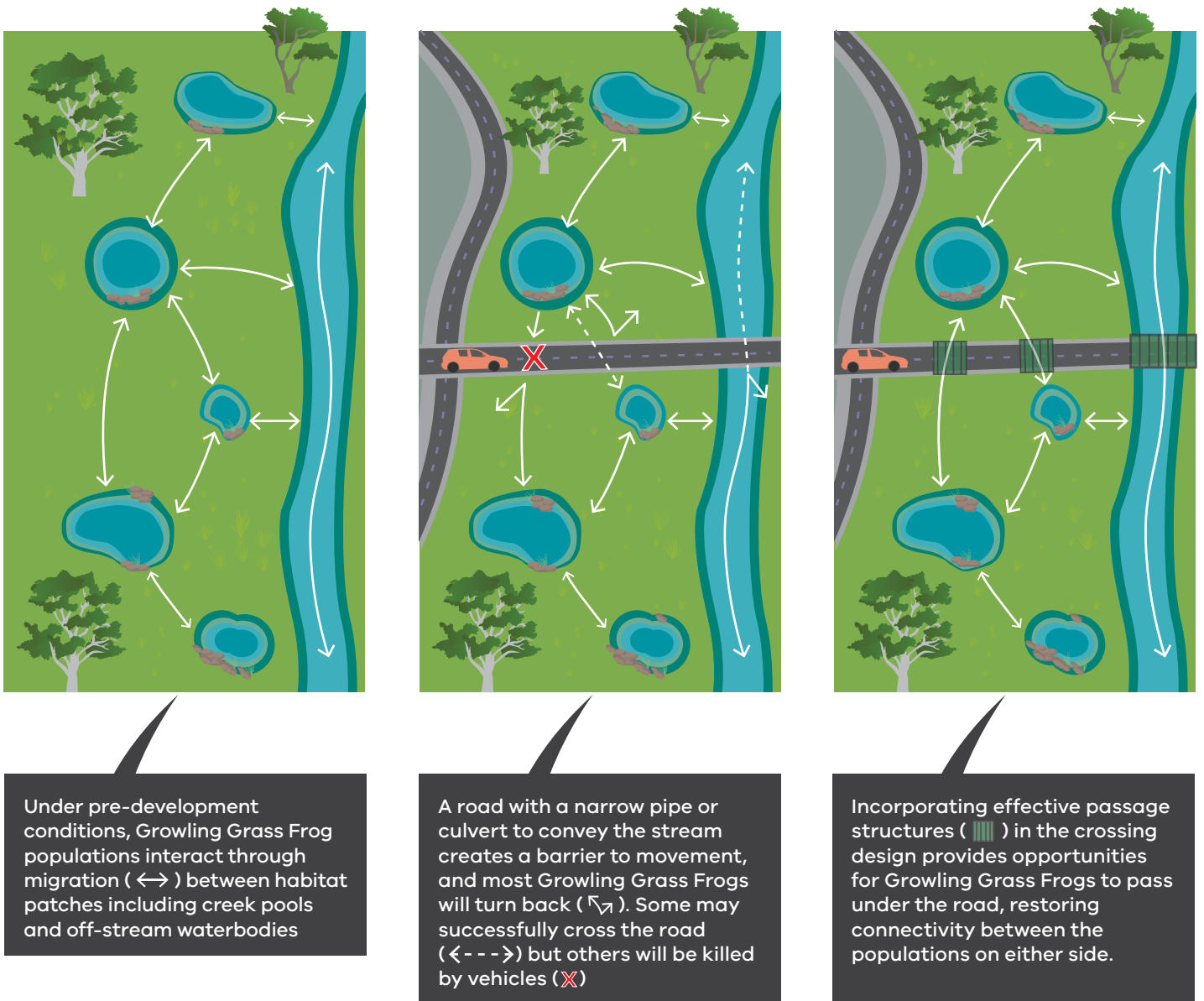
Much of the knowledge included in these standards has also been gained from observations of passages constructed under roads in the greater Melbourne area.

The barrier effect of roads – and the influence of crossing structures in mitigating those impacts – are shown in Figure 2.



The conditions inside regular small box culverts are colder, darker and drier than outside, and there is no conclusive evidence that Growling Grass Frogs use them to pass under roads. Photo by Peter Robertson, Wildlife Profiles Pty Ltd

Figure 2 The ability of Growling Grass Frogs to move along the corridor depends on the barrier effect of infrastructure crossing the conservation area



Crossings in conservation areas

Application of this standard

The *Growling Grass Frog Crossing Design Standards* apply in all Growling Grass Frog conservation areas and any adjacent sections of waterway that have been identified as Nature Conservation areas under the *Biodiversity Conservation Strategy for Melbourne's Growth Corridors*.

Targets for openness apply only to the section of crossing that is within 50 metres of the creek or river (a total of 100 metres – unless the conservation area is narrower). In addition to that waterway passage, terrestrial culverts are required under roads through Growling Grass Frog conservation areas to provide passage for Growling Grass Frogs moving between off-stream habitats (including, but not limited to, existing and new breeding wetlands).

The crossing type required by Melbourne Water to manage flood conveyance and river health will provide a base standard for all crossings. The incorporation of Growling Grass Frog standards into the functional design of the crossing is important for connectivity.

The Growling Grass Frog conservation areas (CA) include:

- CA 14 - Lollypop Creek, Werribee River and Davis Creek
- CA 15 - Kororoit Creek and Deanside Wetlands
- CA 21 - Jacksons Creek and Emu Creek
- CA 34 - Merri Creek and Darebin Creek
- CA 36 - Clyde Creek, Cardinia Creek, Toomuc Creek and Gum Scrub Creek

Principles for location and design of crossings

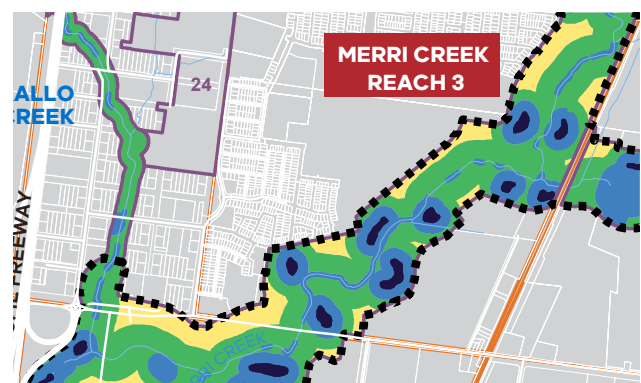
Limit the number of crossings

Reduce the impacts of barriers on the Growling Grass Frog by minimising the number of structures crossing the creek or river. This will require a shared understanding and improved planning along the growth corridor and in particular the surrounding precincts.

Avoid Areas of Strategic Importance

Once the number of crossings have been minimised, the crossing should be located to avoid and minimise impacts on Areas of Strategic Importance (DELWP 2017). Areas of Strategic Importance are areas:

1. containing existing high quality habitat (currently or highly likely to contain key habitat attributes required for breeding as well as foraging and dispersal);
2. containing existing medium quality habitat (currently supports one or more - but not all - key habitat attributes); or
3. that may be required for Growling Grass Frog wetland creation or enhancement and associated (50 metre) buffers.





Construct wide openings over waterways

The opening (bridge or culvert) over the waterway should be wide enough to allow Growling Grass Frogs to travel along the banks during frequent high flows, and to maintain relatively natural climatic conditions in the affected section of the waterway.

Melbourne Water will provide guidance on the type of crossing (bridge or culvert) based on the requirements for flood conveyance, river health and the form and size of the waterway.

Waterway size is measured by the Strahler stream ordering system, which is used by Melbourne Water to characterise and map all of its waterways (Melbourne Water 2013a). Waterway stream order within the Growling Grass Frog conservation areas is shown in Appendix 1.

Waterway form is defined according to the “stream form visions” of Melbourne Water’s Healthy Waterways Strategy (Melbourne Water 2013b). In accordance with Melbourne Water requirements, the impacts to the physical form of the waterway must be minimised.

Provide terrestrial culverts to facilitate movement between off-stream habitats

Openings under roads through Growling Grass Frog conservation areas must also be provided to enable frogs to easily move through the landscape beyond the immediate stream environs. These terrestrial culverts must be located so that most Growling Grass Frogs will encounter an opening under the road barrier as they travel through the conservation area, particularly if they are trying to move between off-stream wetlands or other significant habitats.

Design requirements for bridges and culverts

The Growling Grass Frog crossing design requirements may be additional to (but not impede) Melbourne Water’s requirements and are based on the following objectives:

- openness - have wide, tall entrances but a short length;
- can be readily encountered by the Growling Grass Frogs - wide entrances, not too far apart;
- provide passage above the frequent fast flows so that Growling Grass Frogs can migrate along the waterway in wet weather; and
- have internal conditions that resemble those outside the structure - natural surface, humidity, temperature, light levels.

Bridge design standards

Where a bridge has been determined to be required it must incorporate the following design elements:

- 30 per cent of the section of road 50 metres each side of the waterway (a 100 metre section in total) must be open for passage if the whole opening is provided by a bridge;
- A minimum set back from top of bank of 5 metres for the bridge abutments. If the top of bank is undefined the opening should at least be the width of the 3 month average recurrence interval (ARI) flow (based upon ultimate developed conditions upstream) plus a minimum of 2 metres horizontal distance each side of the waterway;
- Hydraulic capacity to meet flood conveyance as required by the relevant water management authority (generally Melbourne Water); and
- A substrate that reflects the natural riparian environment.

Culvert design standards

Wide arched culverts or a suite of permanently inundated box culverts (for example Koehler and Gilmore 2014) are preferred on the basis that they provide internal conditions that should allow or facilitate Growling Grass Frog passage under roads.

Regular box culverts that are normally dry are generally not acceptable, as they have not been shown to provide adequate passage for Growling Grass Frogs.

Where culverts are determined to be the minimum requirement for passage over a waterway, they must incorporate the following design elements:

- 40 per cent of the crossing over the section of road 50 metres each side of the waterway (a 100 metre section in total) must be open for passage if constructing arched culverts or permanently inundated box culverts; 50 per cent if using regular box culverts that are normally dry;
- An opening that is at least the width of the 3 month ARI flow plus a minimum of 2 metres (horizontally) each side of the waterway;
- Hydraulic capacity to meet flood conveyance as required by the relevant floodplain/drainage authority (generally Melbourne Water); and
- The design requirements in Table 1.

Lighting standards

Directional lighting must be installed on all roads crossing conservation areas to reduce light spill beyond the road. Artificial lighting should be minimised close to Growling Grass Frog crossing structure entrances (fewer lights, decreased height and/or directed to minimise light-spill) to the extent that applicable safety considerations allow.



A bridge provides relatively natural conditions and easy passage along the creek and its banks. Photo by Kathy Preece

Table 1 Culvert design attributes and standards

Attribute	Design standard	Rationale
Configuration	Maximum distance between passages of 50 metres.	To ensure that Growling Grass Frogs moving through the landscape can easily encounter the passages under roads.
Substrate	Preferably natural surface. Concrete with a smooth base may be acceptable in some circumstances, for example permanently inundated box culverts.	To provide relatively natural conditions and minimise obstacles that may impede direct movement.
Dimensions – all culverts	Straight and as wide and short as possible. Entrance as close to the road edge as possible.	To minimise the distance that needs to be traversed, reduce the difference in climate between inside and outside the culvert and provide a sight line to the end.
Dimensions of waterway culverts	An opening that is at least the width of the 3 month ARI flow plus a minimum of 2 metres (horizontally) each side of the waterway Minimum airspace of 600 mm for any culvert across a waterway that will be inundated during baseflow conditions.	To enable passage along the stream bank in frequent flow conditions. To try to maintain climatic equilibrium between the inside and outside environments; allow water conveyance and allow frogs to breathe while in the culvert.
Dimensions of terrestrial culverts	Each arched culvert or set of multiple box culverts is to provide a horizontal opening of at least 10 metres. Permanently inundated culverts must contain standing water approximately 300 mm deep. A supply of suitable water (for example treated stormwater) must be identified as part of the design. Culverts for infrastructure that is level with terrestrial habitat must have bases dug in below natural surface if required.	To provide opportunity for Growling Grass Frog to find passages, and to try to maintain climatic equilibrium between the inside and outside environments. A maximum transition grade of 1 in 10 to the culvert invert must be incorporated in the design.
Light and moisture	Install microclimate vents that: <ol style="list-style-type: none"> 1. Have footprint of at least 1 metre x 1 metre and preferably much larger. 2. Are placed adjacent to the kerb and channel on either side of a two lane road. 3. Have an additional vent in the central median for larger roads so that there is no more than 10 metres between vents. 4. Consist of a "grated lid" with a 500 mm concrete surround that falls towards the grate. 	To allow light and moisture to penetrate the culvert, to try to maintain climatic equilibrium between the inside and outside environments.

Figure 3 A combination of bridge and culverts in a road crossing a Growing Grass Frog conservation area

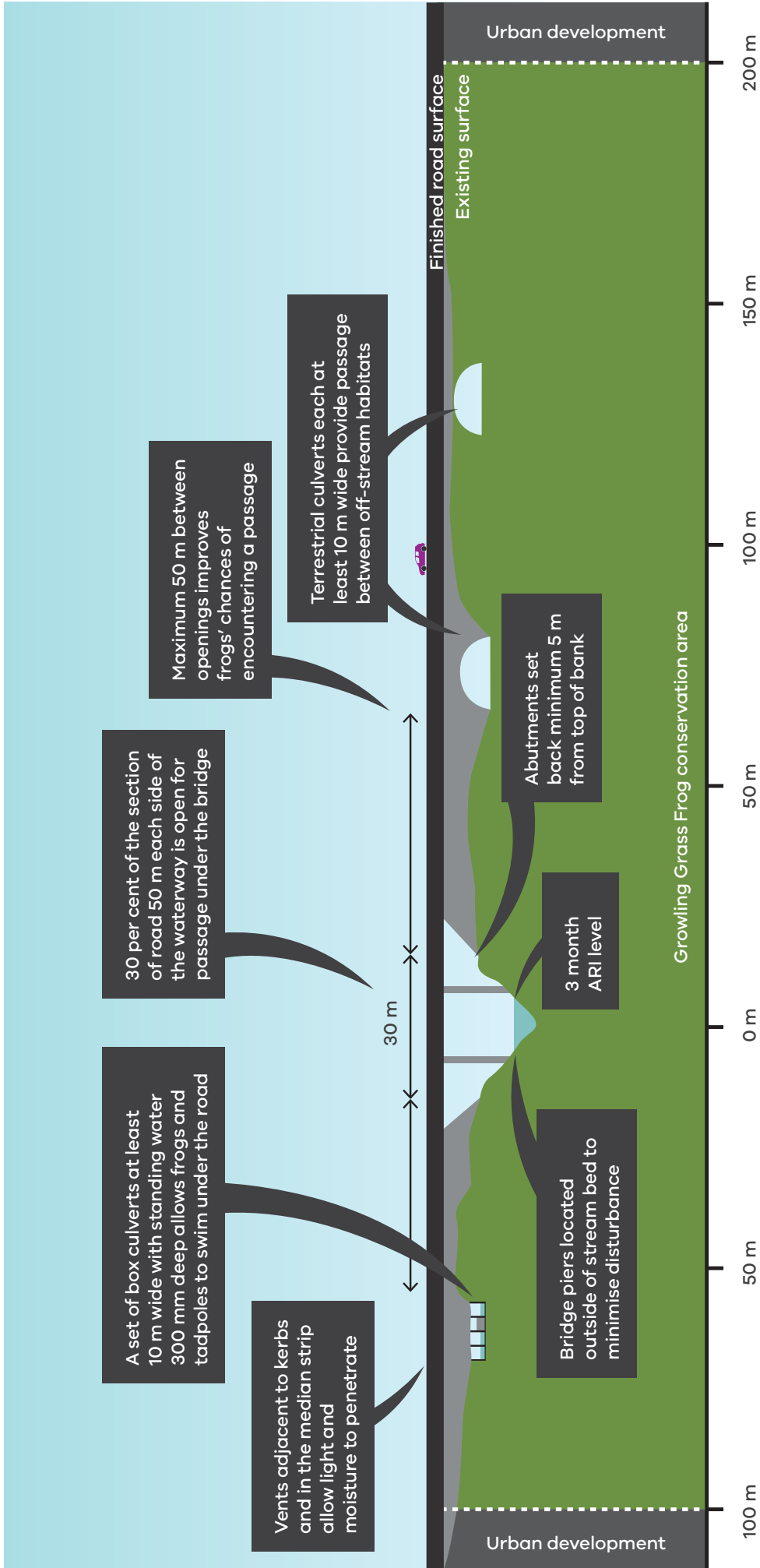
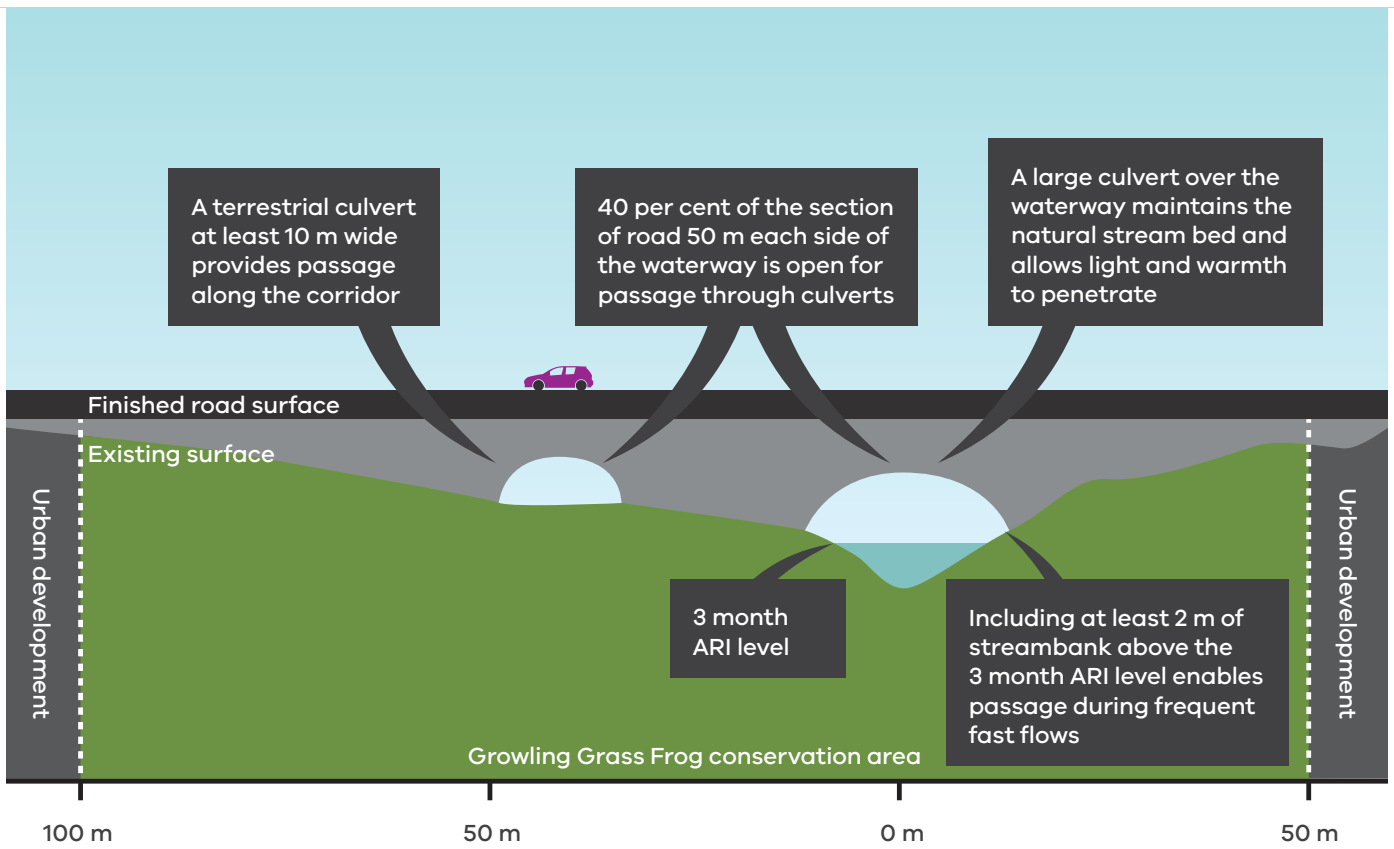
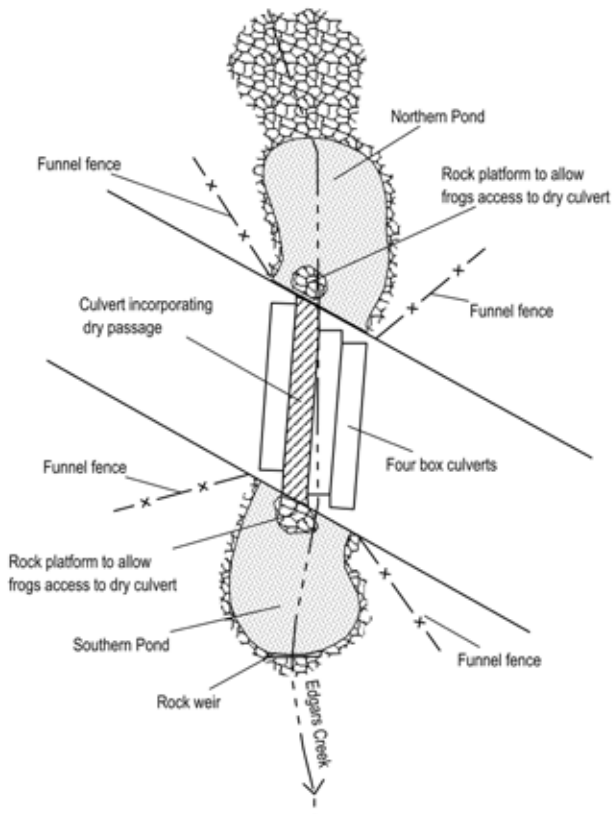


Figure 4 Crossing with arched culverts



The combination of a separated carriageway and arched culverts results in frogs being able to easily travel along the waterway (in this case a constructed section of Aitken Creek) under a busy four-lane arterial road. These prefabricated arches can be installed with little disturbance to the stream bed and banks in Growing Grass Frog conservation areas. Photo by Kathy Preece

Figure 5 Inundated box culvert design



The box culverts were set in under the road verge, to reduce the length of the passage.



A 10 metre wide set of culverts, three of which are permanently inundated, provide passage for Growling Grass Frogs under a two-lane road over Edgars Creek. All images by Daniel Gilmore, Biosis Pty Ltd



A large vent in the median strip improves conditions for Growling Grass Frogs in a long culvert under the Calder Freeway. Photos by Kathy Preece

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Appendix: Strahler stream order for waterways within the Melbourne Strategic Assessment conservation areas

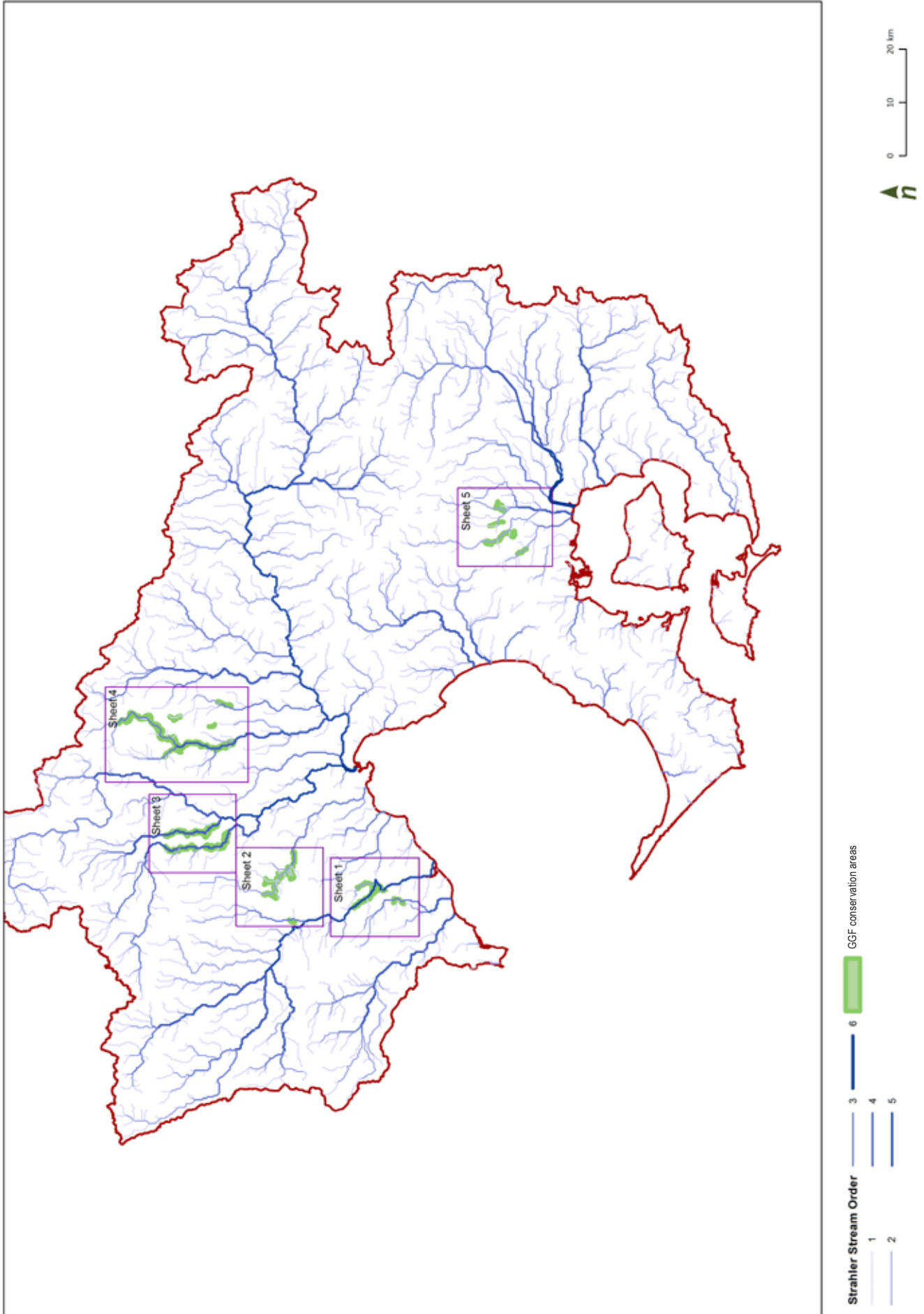


High quality instream habitat for Growling Grass Frogs (Merri Creek). Photo by Kathy Preece

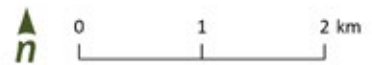
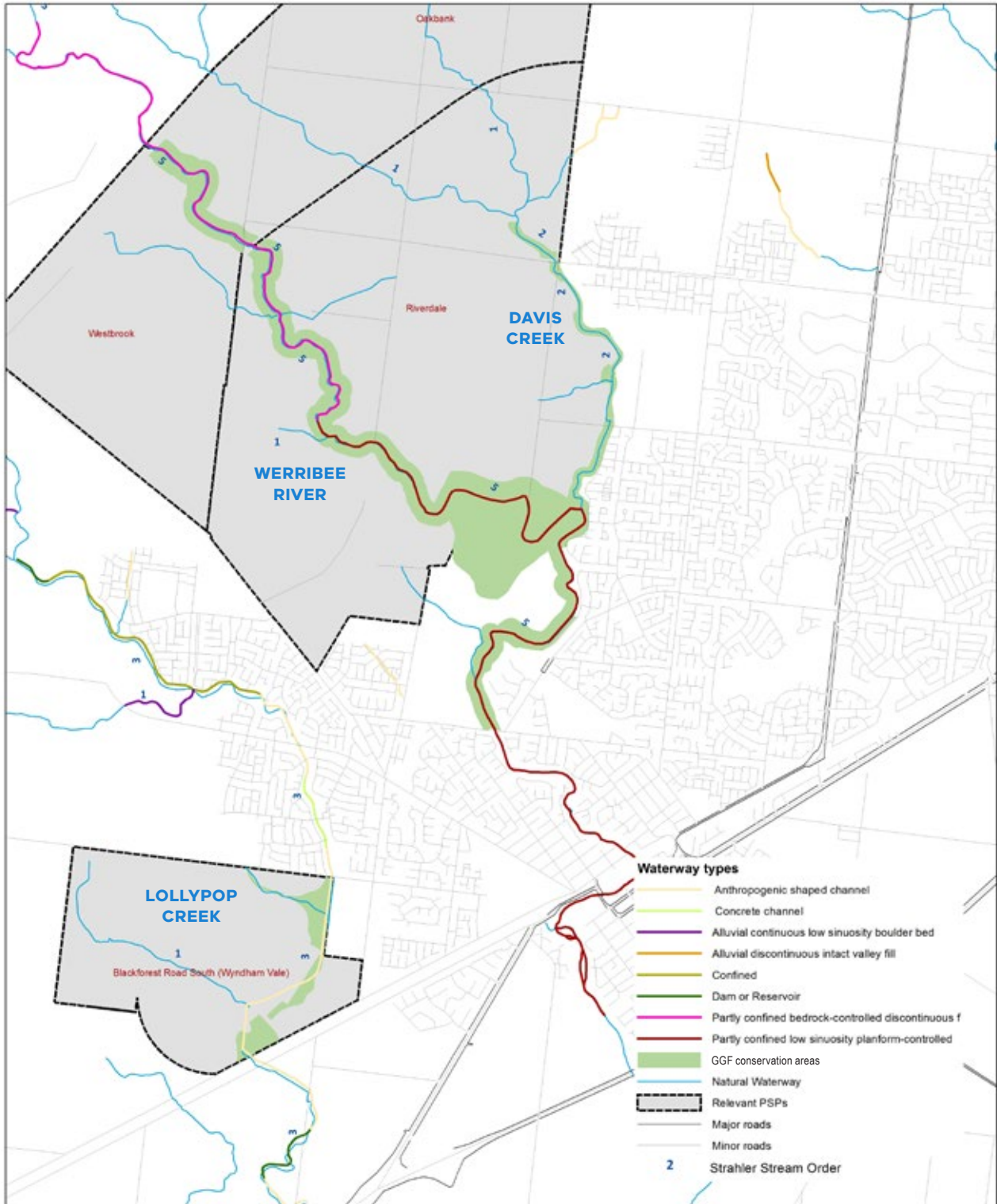
Waterway stream orders based on the Strahler stream order system are shown in the following figures for each of the conservation areas:

- Western Growth Corridor (Werribee River, Davis Creek, Lollypop Creek, Kororoit Creek);
- North West Growth Corridor (Jacksons Creek, Emu Creek);
- Northern Growth Corridor (Merri Creek, Darebin Creek); and
- South East Growth Corridor (Cardinia Creek, Toomuc Creek).

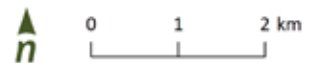
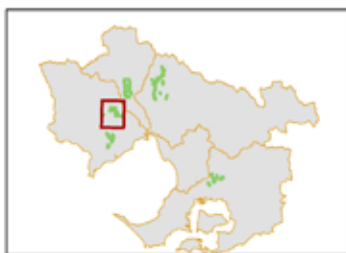
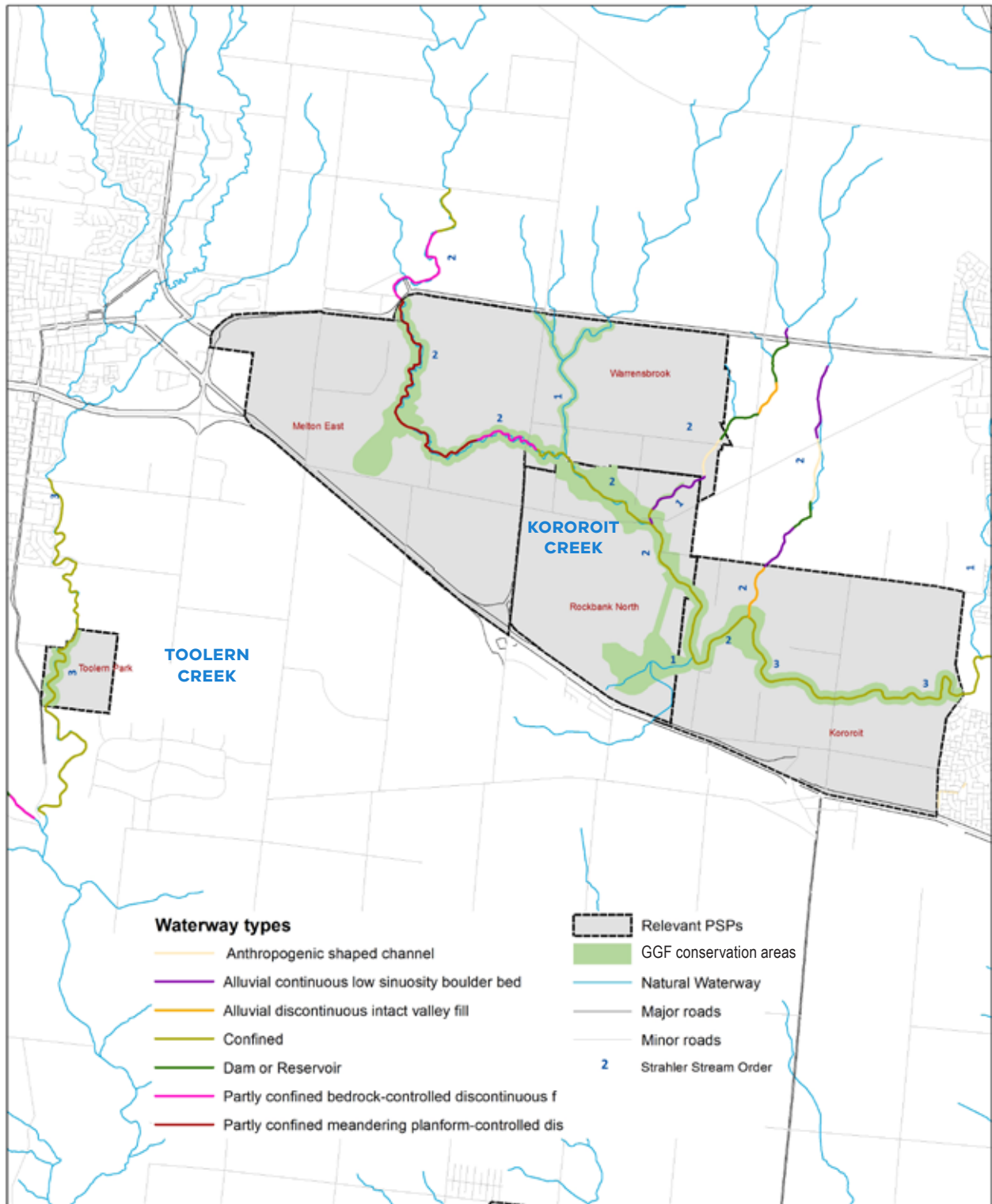
Growling Grass Frog conservation areas - overview of Strahler stream order



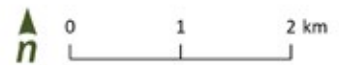
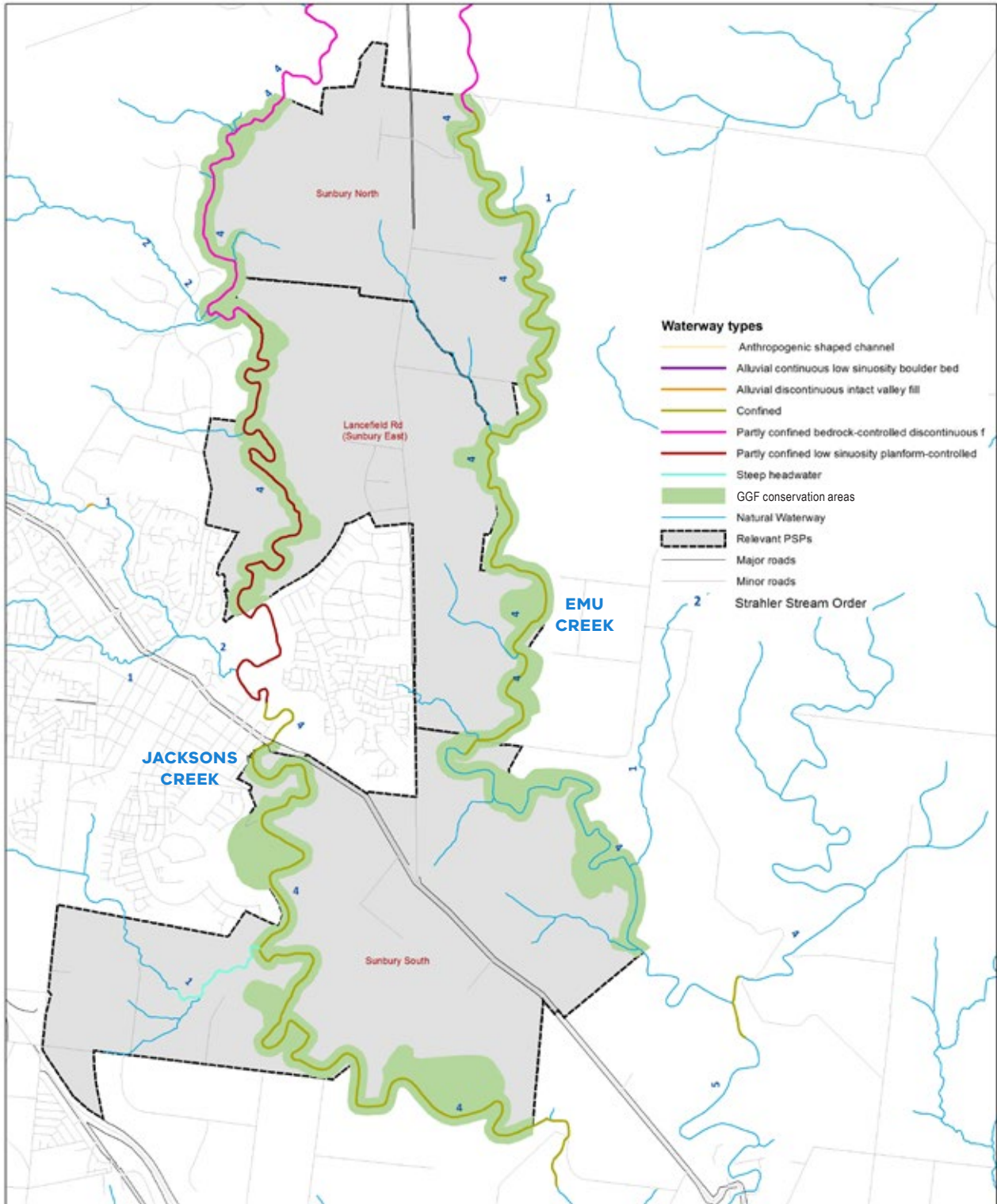
Growling Grass Frog conservation area 14 - Werribee catchment lower



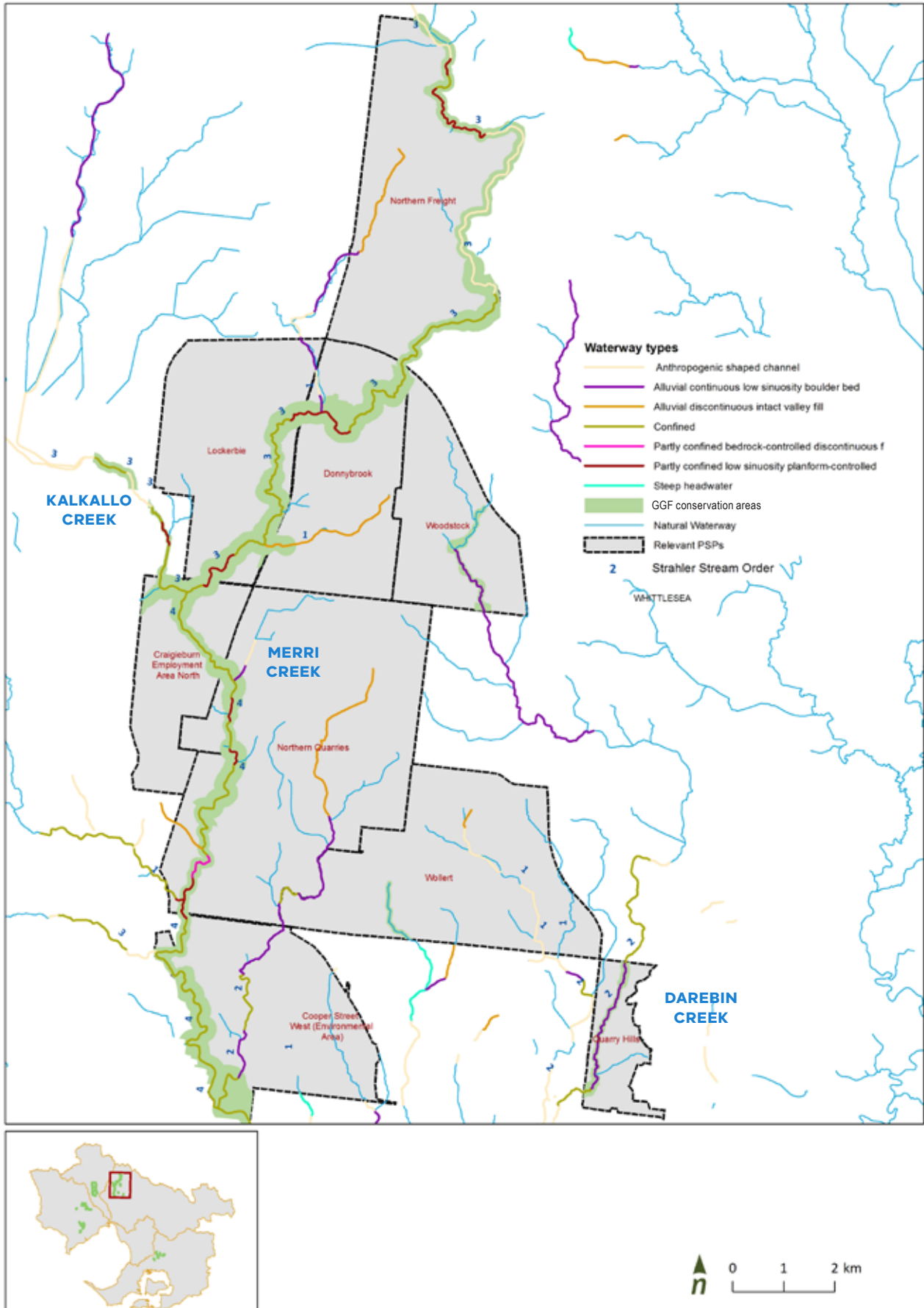
Growing Grass Frog conservation area 15 - Werribee catchment upper



Growling Grass Frog conservation area 21 - Maribyrnong catchment



Growling Grass Frog conservation area 34 - Yarra catchment



Growling Grass Frog conservation area 36 - Western Port

