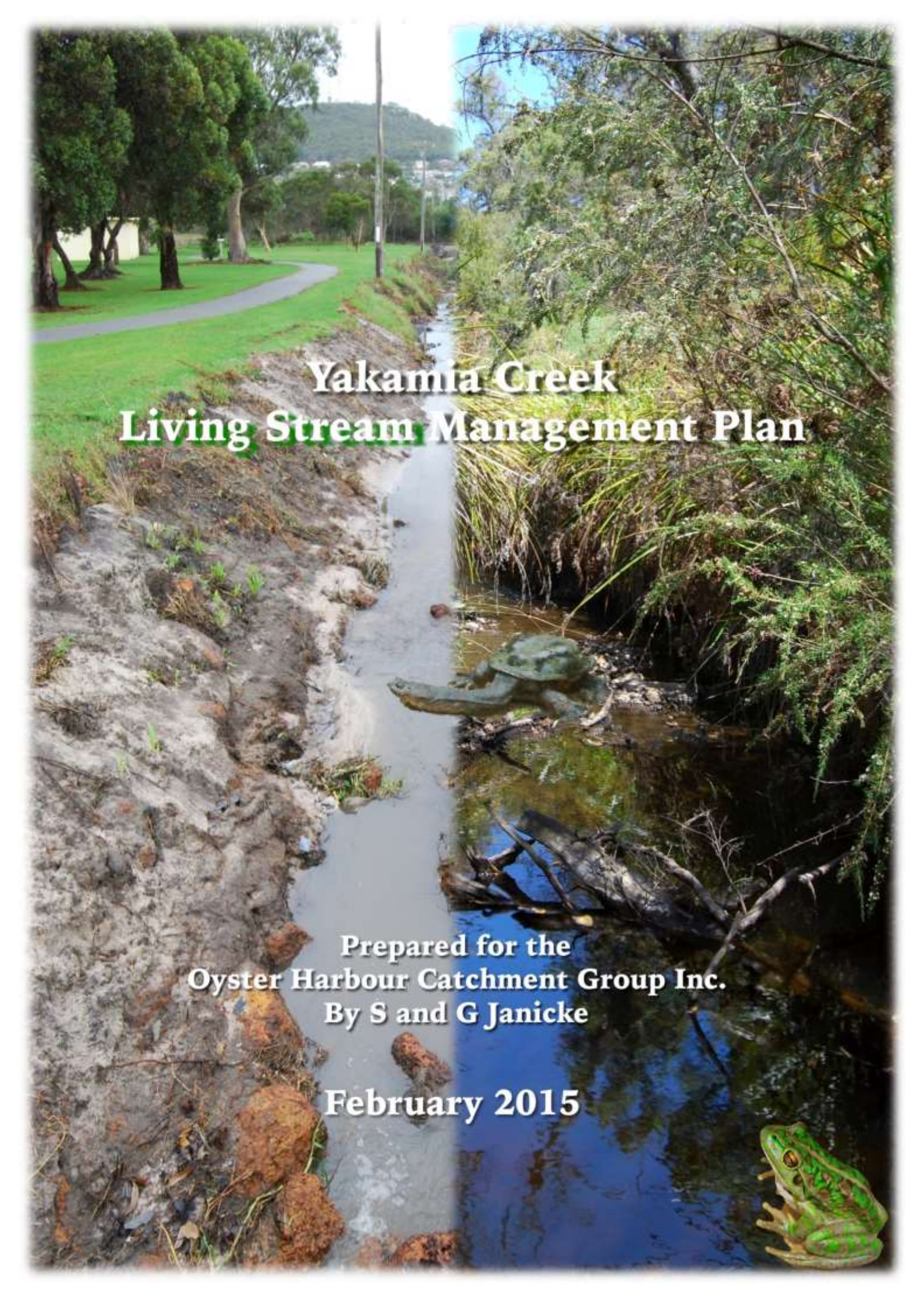


The background image is a photograph of a creek. On the left, a paved path curves through a green lawn with several trees. The creek itself is narrow and flows from the background towards the foreground. The right bank is heavily vegetated with tall grasses and shrubs. In the middle of the creek, a large green frog is perched on a rock. In the bottom right corner, another green frog is visible. The text is overlaid on the image in a white, serif font.

Yakamia Creek Living Stream Management Plan

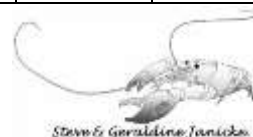
**Prepared for the
Oyster Harbour Catchment Group Inc.
By S and G Janicke**

February 2015

APPENDIX 1: Constraints scoring for each section of Yakamia Creek.

Priority	Tier 1	0 - 5	Initial, feasible targets for Living Stream rehabilitation
colour coding	Tier 2	6 - 10	Future potential, but with one or two significant issues to take into account.
	Tier 3	11 - 20	Problematic, with multiple development issues to consider
	Tier 4	> 20	Highly constrained (do nothing)

Section	Sum of Constraints	Section length (m)	Section length score	Riparian connectivity up and down stream	Capacity to add channel sinuosity.	Width available for riparian veg.	Capacity to alter cross-section	Conveyance stormwater infrastructure	Land tenure	Land tenure score	Public amenity	Maintenance
Yak_A01.1	8	137.3	0	0	0	0	0	0	Freehold	3	2	3
Yak_A01.2	7	44.5	2	3	0	1	0	0	Reserve	0	1	0
Yak_A02	24	514.7	0	3	3	3	3	3	Piped	3	3	3
Yak_A03	15	31.0	3	3	2	2	0	1	Road reserve	3	1	0
Yak_A04	23	70.5	1	3	3	3	3	3	Road reserve	1	3	3
Yak_A05.1	5	37.1	2	3	0	0	0	0	Reserve	0	0	0
Yak_A05.2	2	111.8	0	1	0	0	0	1	Reserve	0	0	0
Yak_A05.3	1	69.7	1	0	0	0	0	0	Reserve	0	0	0
Yak_A05.r	27	13.4	3	3	3	3	3	3	Culvert	3	3	3
Yak_A06	18	106.6	0	2	3	3	3	2	Easement	1	2	2
Yak_A06.r	27	24.1	3	3	3	3	3	3	Culvert	3	3	3



Yakamia Creek Living Stream Management Plan

Section	Sum of Constraints	Section length (m)	Section length score	Riparian connectivity up and down stream	Capacity to add channel sinuosity.	Width available for riparian veg.	Capacity to alter cross-section	Conveyance stormwater infrastructure	Land tenure	Land tenure score	Public amenity	Maintenance
Yak_A07	9	41.4	2	3	2	0	0	0	Road reserve	1	1	0
Yak_A08	12	91.9	1	3	0	0	0	3	Reserve & Freehold	3	2	0
Yak_A09	9	27.6	3	3	0	0	0	2	Reserve	0	1	0
Yak_A10	24	203.0	0	3	3	3	3	3	Easement	3	3	3
Yak_A11	4	66.2	1	3	0	0	0	0	Reserve	0	0	0
Yak_B1	12	72.4	1	1	1	1	0	1	Freehold	3	1	3
Yak_B2	7	163.6	0	0	0	0	0	0	Freehold	3	1	3
Yak_B3	10	47.1	1	0	0	0	0	0	Freehold	3	3	3
Yak_B4	8	66.6	1	1	3	2	0	1	Road reserve	0	0	0
Yak_B4.r	27	15.4	3	3	3	3	3	3	Culvert	3	3	3
Yak_B5	10	64.2	1	1	2	0	0	0	Freehold	3	0	3
Yak_B6.1	1	127.9	0	0	0	0	0	1	Reserve	0	0	0
Yak_B6.2	2	73.1	1	0	0	0	0	1	Reserve	0	0	0
Yak_B7	1	194.4	0	0	0	0	0	1	Reserve	0	0	0



Yakamia Creek Living Stream Management Plan

Section	Sum of Constraints	Section length (m)	Section length score	Riparian connectivity up and down stream	Capacity to add channel sinuosity.	Width available for riparian veg.	Capacity to alter cross-section	Conveyance stormwater infrastructure	Land tenure	Land tenure score	Public amenity	Maintenance
Yak_B8	5	138.7	0	3	1	0	0	1	Reserve	0	0	0
Yak_B9	24	129.3	0	3	3	3	3	3	Piped	3	3	3
Yak_C1	5	170.6	0	3	1	0	0	1	Reserve	0	0	0
Yak_C2	2	86.2	1	1	0	0	0	0	Reserve	0	0	0
Yak_C3	0	124.1	0	0	0	0	0	0	Reserve	0	0	0
Yak_C4	5	134.0	0	0	2	1	0	2	Reserve	0	0	0
Yak_C5	10	83.0	1	0	3	2	2	2	Reserve	0	0	0
Yak_C6	9	90.7	1	1	3	2	0	2	Reserve	0	0	0
Yak_C6.r	27	18.4	3	3	3	3	3	3	Culvert	3	3	3
Yak_C7	15	99.8	0	2	3	3	3	2	Reserve	2	0	0
Yak_C8	6	127.5	0	2	1	1	0	2	Reserve	0	0	0
Yak_C8.r	27	16.5	3	3	3	3	3	3	Culvert	3	3	3
Yak_C9.1	4	149.8	0	1	0	1	0	2	Reserve	0	0	0
Yak_C9.2	3	122.8	0	3	0	0	0	0	Reserve	0	0	0
Yak_C10	27	75.6	3	3	3	3	3	3	Piped	3	3	3



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Section	Sum of Constraints	Section length (m)	Section length score	Riparian connectivity up and down stream	Capacity to add channel sinuosity.	Width available for riparian veg.	Capacity to alter cross-section	Conveyance stormwater infrastructure	Land tenure	Land tenure score	Public amenity	Maintenance
Yak_Ct1	4	254.6	0	3	0	0	0	1	Reserve	0	0	0
Yak_Ct2	24	359.3	0	3	3	3	3	3	Piped	3	3	3
Yak_Ct3	4	249.9	0	3	0	0	0	1	Reserve	0	0	0
Yak_Ct4	1	81.7	1	0	0	0	0	0	Reserve	0	0	0
Yak_Ct5	7	206.2	0	1	3	2	1	0	Reserve	0	0	0
Yak_Ct6	3	181.6	0	0	0	0	3	0	Reserve	0	0	0
Yak_Ct7	1	100.8	0	0	1	0	0	0	Reserve	0	0	0
Yak_Ct8	16	23.6	3	3	3	2	3	2	Reserve	0	0	0
Yak_Ct8.r	27	13.3	3	3	3	3	3	3	Culvert	3	3	3
Yak_D1.1	6	138.1	0	1	2	0	1	0	Reserve	0	2	0
Yak_D1.2	4	265.7	0	0	1	0	0	1	Reserve	0	2	0
Yak_D2.1	10	217.2	0	0	0	0	0	1	Freehold	3	3	3
Yak_D2.2	6	118.3	0	0	0	0	0	0	Easement	1	3	2
Yak_D2.3	7	83.4	1	0	0	0	0	0	Easement	1	3	2
Yak_D2.4	6	86.4	1	0	0	0	0	0	Reserve	0	3	2



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Section	Sum of Constraints	Section length (m)	Section length score	Riparian connectivity up and down stream	Capacity to add channel sinuosity.	Width available for riparian veg.	Capacity to alter cross-section	Conveyance stormwater infrastructure	Land tenure	Land tenure score	Public amenity	Maintenance
Yak_D2.5	7	91.1	1	0	0	0	0	0	Easement	1	3	2
Yak_D2.6	8	65.5	1	0	0	0	0	1	Easement	1	3	2
Yak_D2.7	6	99.3	1	0	0	0	0	0	Reserve	0	3	2
Yak_D3.1	9	104.9	0	0	0	0	0	0	Freehold	3	3	3
Yak_D3.2	9	100.8	0	0	0	0	0	0	Freehold	3	3	3
Yak_D3.3	10	110.2	0	0	0	0	0	1	Freehold	3	3	3
Yak_D4.1	9	113.5	0	0	0	0	0	0	Freehold	3	3	3
Yak_D4.2	9	204.2	0	0	0	0	0	0	Freehold	3	3	3
Yak_D4.3	9	104.9	0	0	0	0	0	0	Freehold	3	3	3
Yak_D4.4	6	178.7	0	0	0	0	0	1	Reserve	0	3	2
Yak_D4.5	9	102.4	0	0	0	0	0	0	Freehold	3	3	3
Yak_D4.6	10	71.2	1	0	0	0	0	0	Freehold	3	3	3
Yak_D4.7	10	72.7	1	0	0	0	0	0	Freehold	3	3	3
Yak_D4.8	9	196.7	0	0	0	0	0	0	Freehold	3	3	3
Yak_D5.1	9	122.7	0	0	0	0	0	0	Freehold	3	3	3



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Section	Sum of Constraints	Section length (m)	Section length score	Riparian connectivity up and down stream	Capacity to add channel sinuosity.	Width available for riparian veg.	Capacity to alter cross-section	Conveyance stormwater infrastructure	Land tenure	Land tenure score	Public amenity	Maintenance
Yak_D5.2	9	160.8	0	0	0	0	0	0	Freehold	3	3	3
Yak_D5.3	9	205.9	0	0	0	0	0	0	Freehold	3	3	3
Yak_D5.4	9	238.3	0	0	0	0	0	0	Freehold	3	3	3
Yak_D5.5	9	210.0	0	0	0	0	0	0	Freehold	3	3	3
Yak_D5.6	10	64.2	1	0	0	0	0	0	Freehold	3	3	3
Yak_D5.7	9	307.9	0	0	0	0	0	0	Freehold	3	3	3
Yak_D5.8	9	358.6	0	0	0	0	0	0	Freehold	3	3	3
Yak_D5.9	6	72.1	1	1	0	0	0	1	Road reserve	1	2	0
Yak_D5.r	24	14.1	3	3	3	3	3	0	Culvert	3	3	3
Yak_E1	10	198.3	0	1	0	0	0	0	Freehold	3	3	3
Yak_E1.r	18	26.1	3	3	3	3	3	0	Road reserve	1	2	0
Yak_E2	9	666.0	0	0	0	0	0	0	Freehold	3	3	3
Yak_E3.1	9	431.7	0	0	0	0	0	0	Freehold	3	3	3
Yak_E3.2	9	377.2	0	0	0	0	0	0	Freehold	3	3	3
Yak_E4	4	210.3	0	0	0	0	0	0	Reserve	0	2	2



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Section	Sum of Constraints	Section length (m)	Section length score	Riparian connectivity up and down stream	Capacity to add channel sinuosity.	Width available for riparian veg.	Capacity to alter cross-section	Conveyance stormwater infrastructure	Land tenure	Land tenure score	Public amenity	Maintenance
Yak_E5	4	157.6	0	0	0	0	0	0	Reserve	0	2	2
Yak_F1.1	10	206.8	0	1	0	0	0	0	Freehold	3	3	3
Yak_F1.2	9	209.9	0	0	0	0	0	0	Freehold	3	3	3
Yak_F1.3	9	225.0	0	0	0	0	0	0	Freehold	3	3	3
Yak_F1.4	11	49.9	2	0	0	0	0	0	Freehold	3	3	3
Yak_F1.5	9	161.1	0	0	0	0	0	0	Freehold	3	3	3
Yak_G1.1	9	231.7	0	0	0	0	0	0	Freehold	3	3	3
Yak_G1.2	9	254.2	0	0	0	0	0	0	Freehold	3	3	3
Yak_G1.3	9	242.4	0	0	0	0	0	0	Freehold	3	3	3
Yak_G2	9	366.5	0	0	0	0	0	0	Freehold	3	3	3
Yak_G2.r	10	21.2	3	0	3	0	0	0	Road reserve	1	2	1
Yak_G3.1	9	120.7	0	0	0	0	0	0	Freehold	3	3	3
Yak_G3.2	9	121.0	0	0	0	0	0	0	Freehold	3	3	3
Yak_G3.3	9	143.9	0	0	0	0	0	0	Freehold	3	3	3
Yak_G3.4	9	131.5	0	0	0	0	0	0	Freehold	3	3	3



Yakamia Creek Living Stream Management Plan

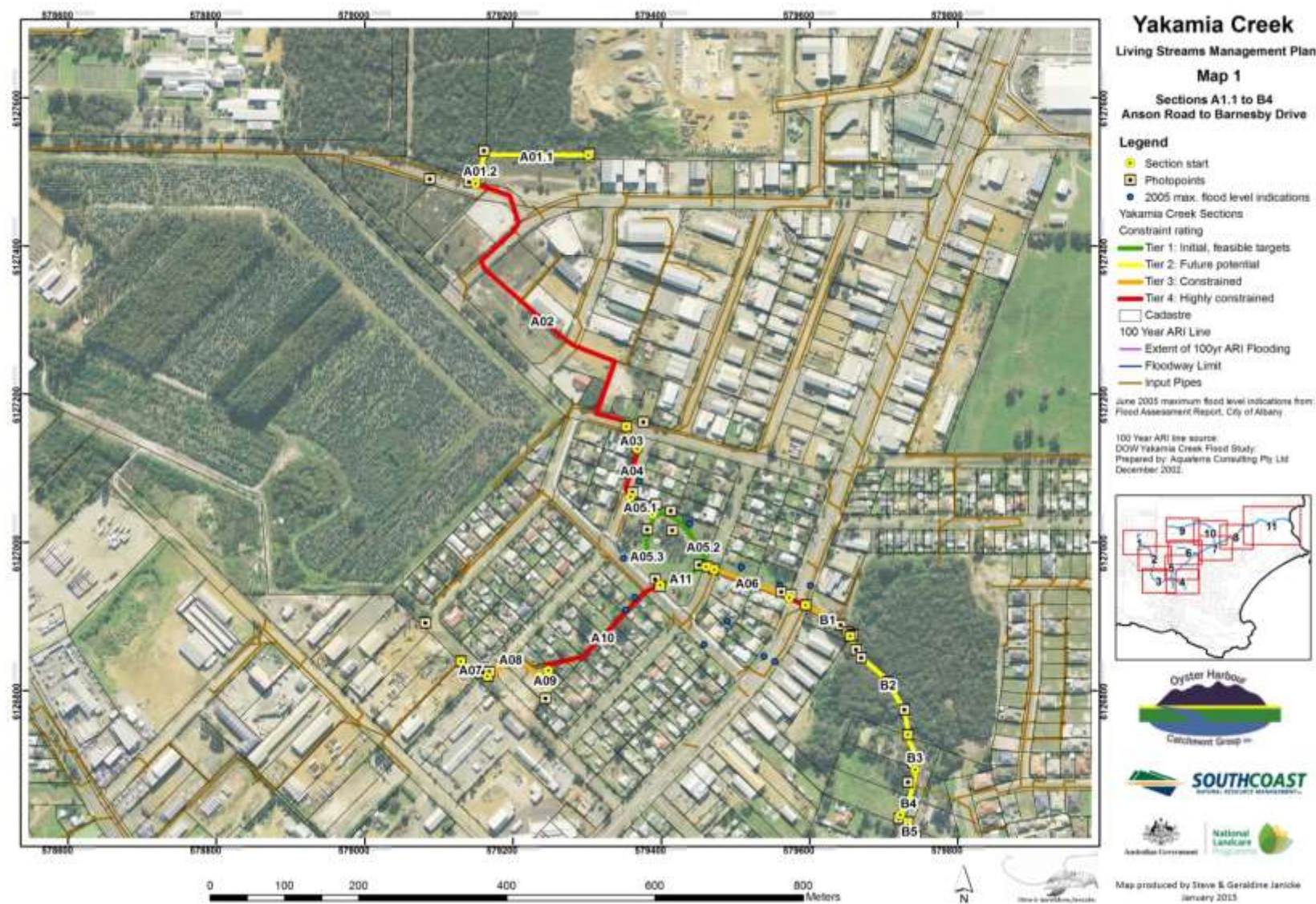
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Yak_G3.5	9	214.1	0	0	0	0	0	0	Freehold	3	3	3
Yak_G3.6	11	43.7	2	0	0	0	0	0	Freehold	3	3	3
Yak_G3.r	10	24.4	3	0	3	0	0	0	Road reserve	1	2	1
Yak_G4.1	9	278.8	0	0	0	0	0	0	Freehold	3	3	3
Yak_G4.2	9	111.4	0	0	0	0	0	0	Freehold	3	3	3
Yak_G5.1	8	218.3	0	0	2	1	0	0	Road reserve	1	2	2
Yak_G5.2	8	199.5	0	0	2	1	0	0	Road reserve	1	2	2
Yak_G5.3	9	105.2	0	0	0	0	0	0	Freehold	3	3	3

APPENDIX 2: Section Maps

The Section Maps are on the following pages.

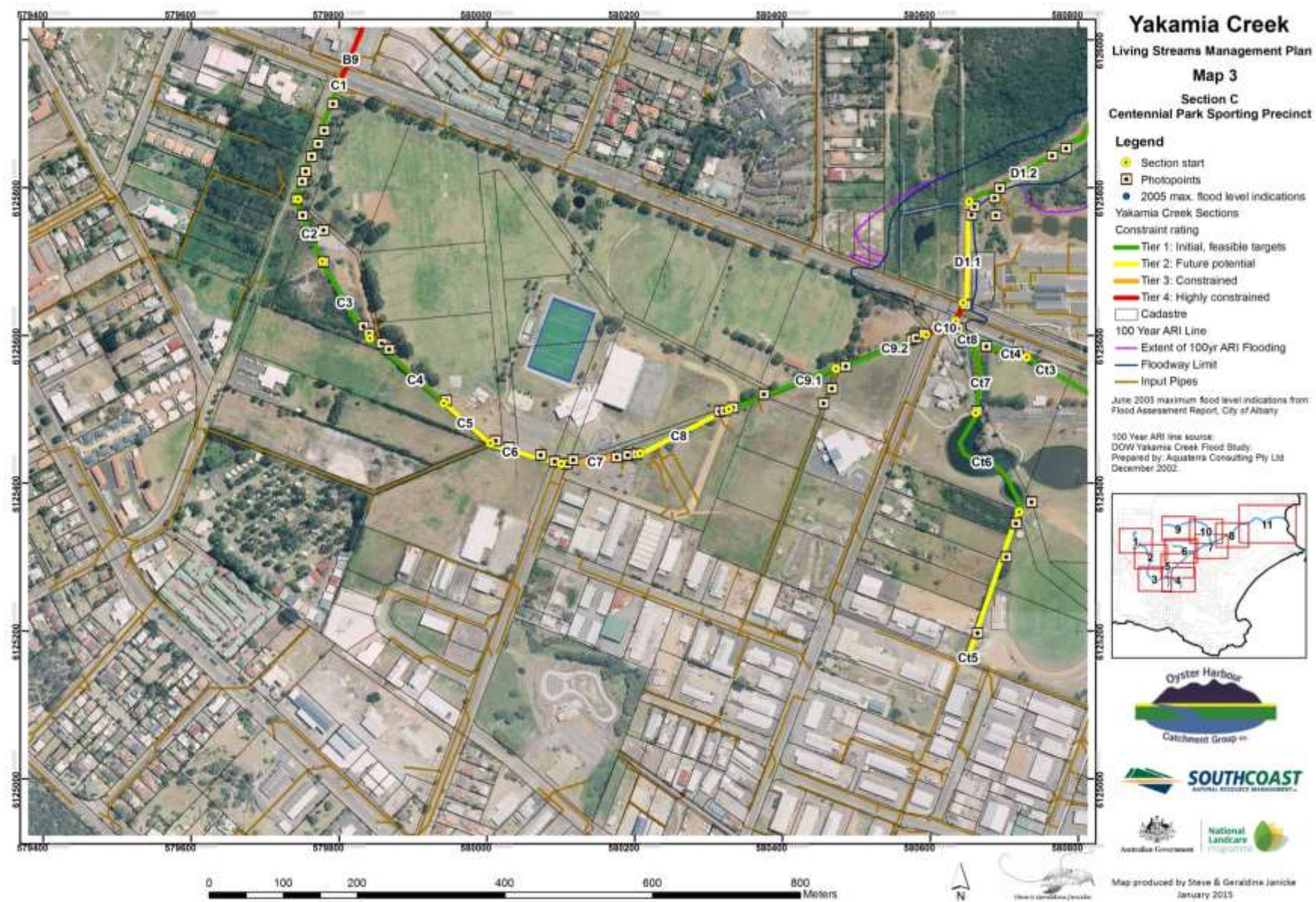


Yakamia Creek Living Stream Management Plan



Yakamia Creek Living Stream Management Plan

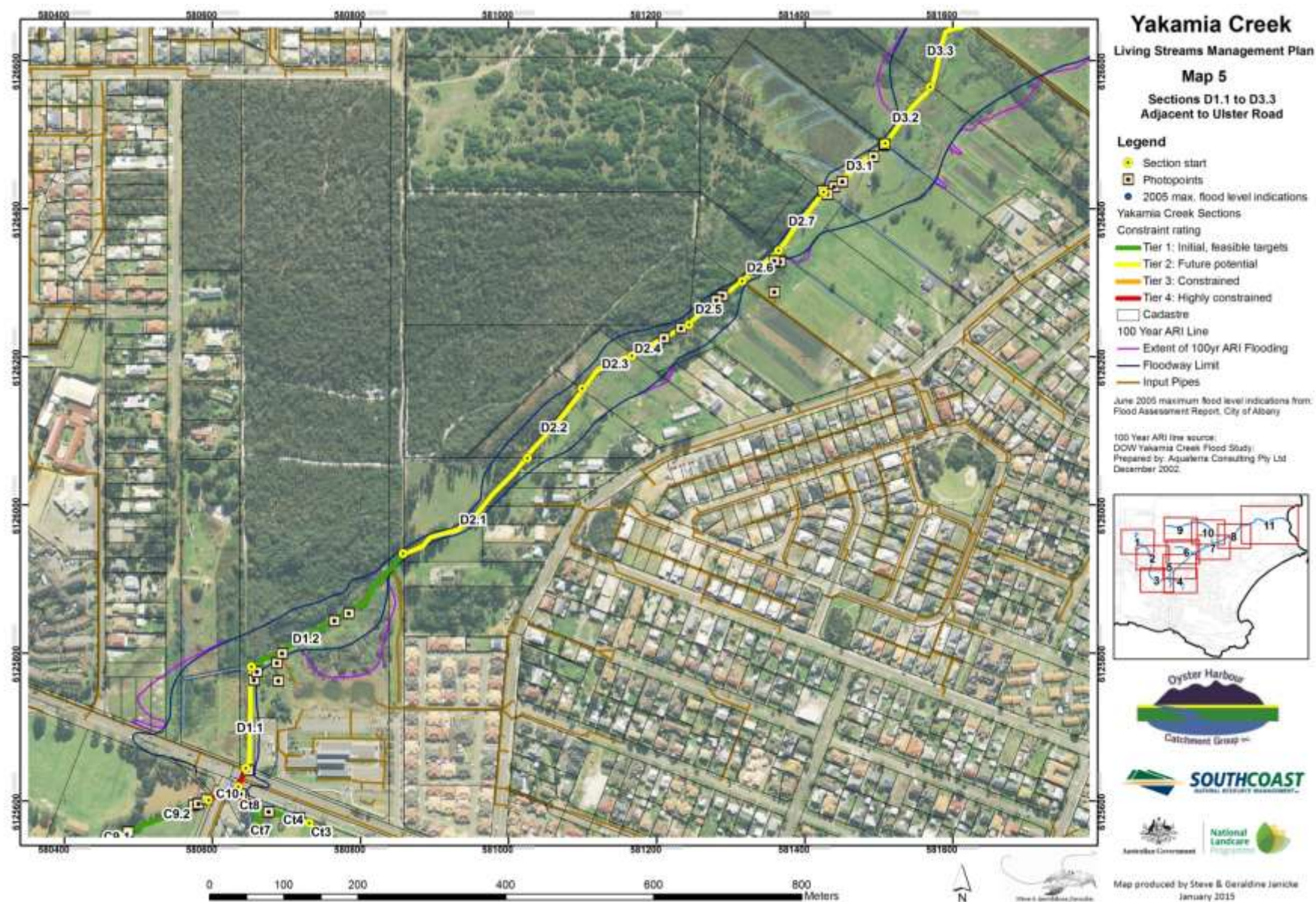




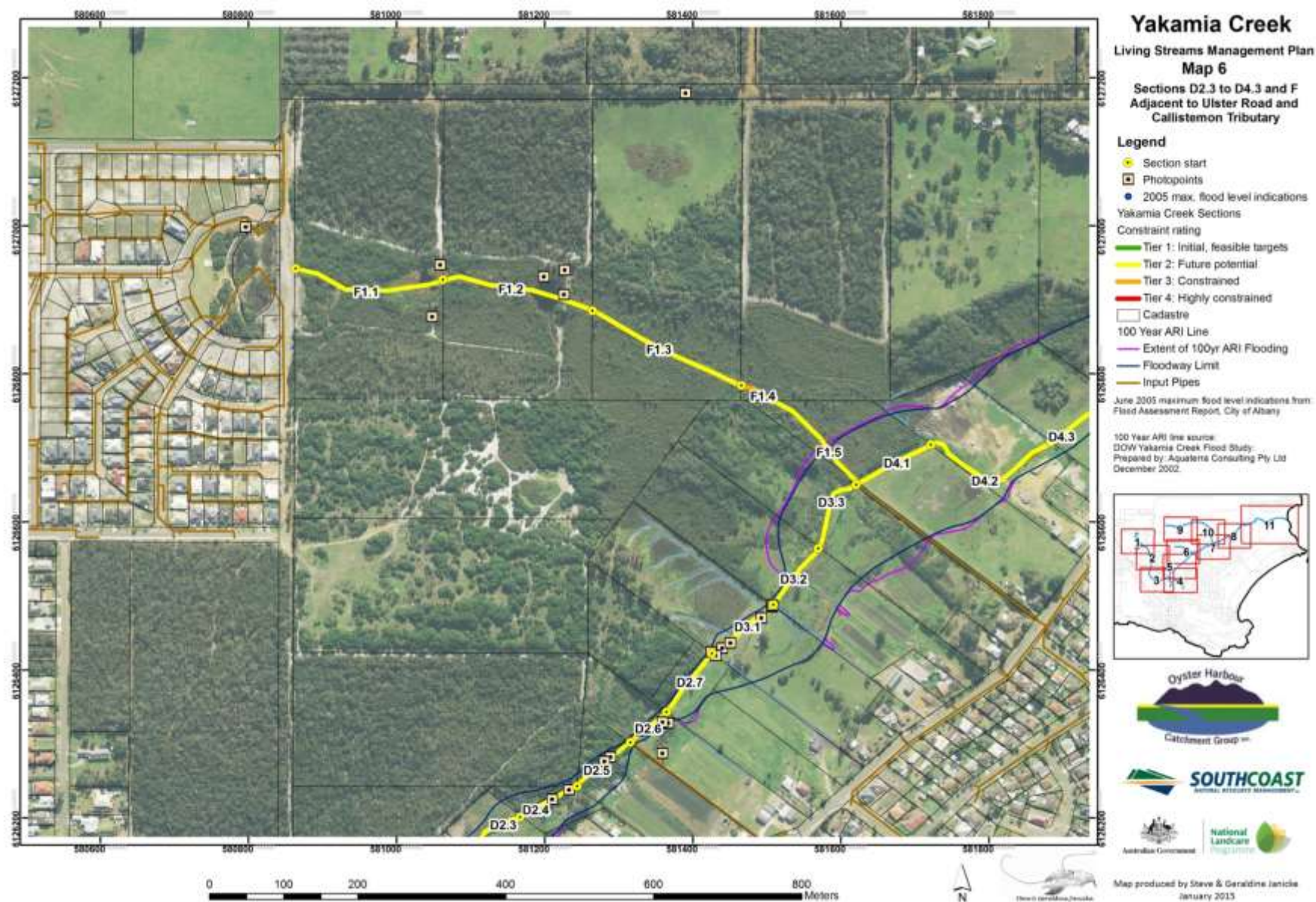
Yakamia Creek Living Stream Management Plan



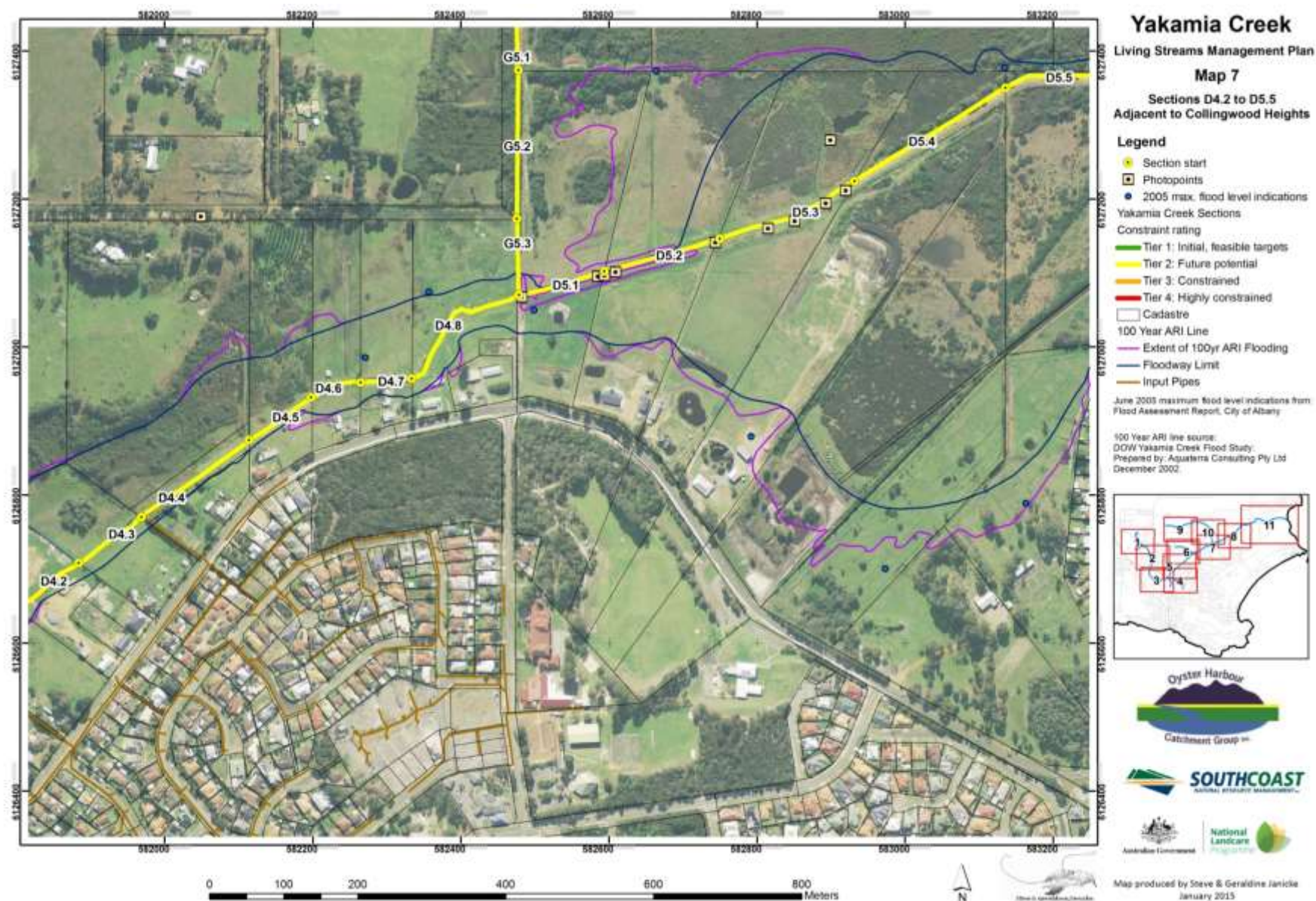
Yakamia Creek Living Stream Management Plan



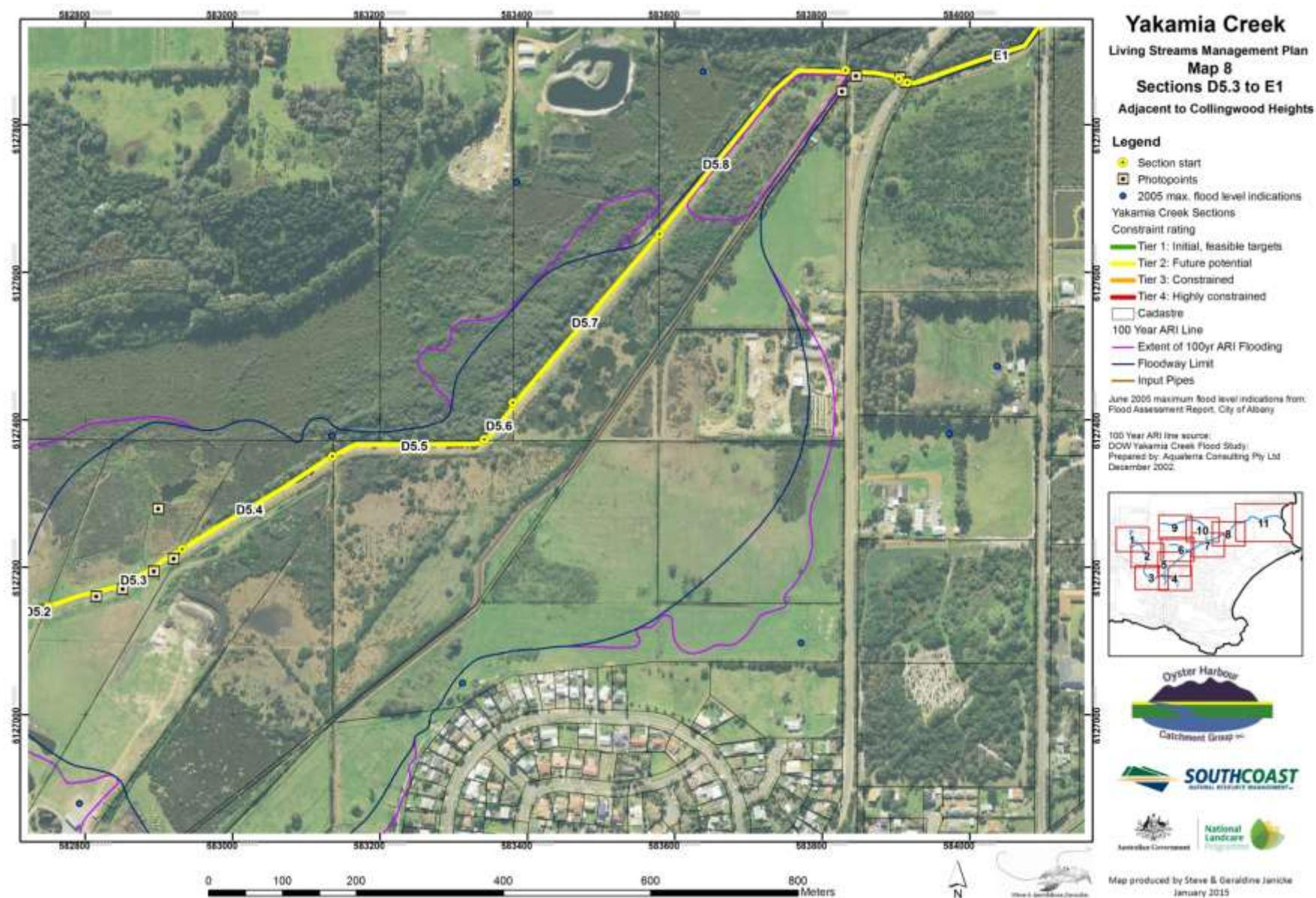
Yakamia Creek Living Stream Management Plan



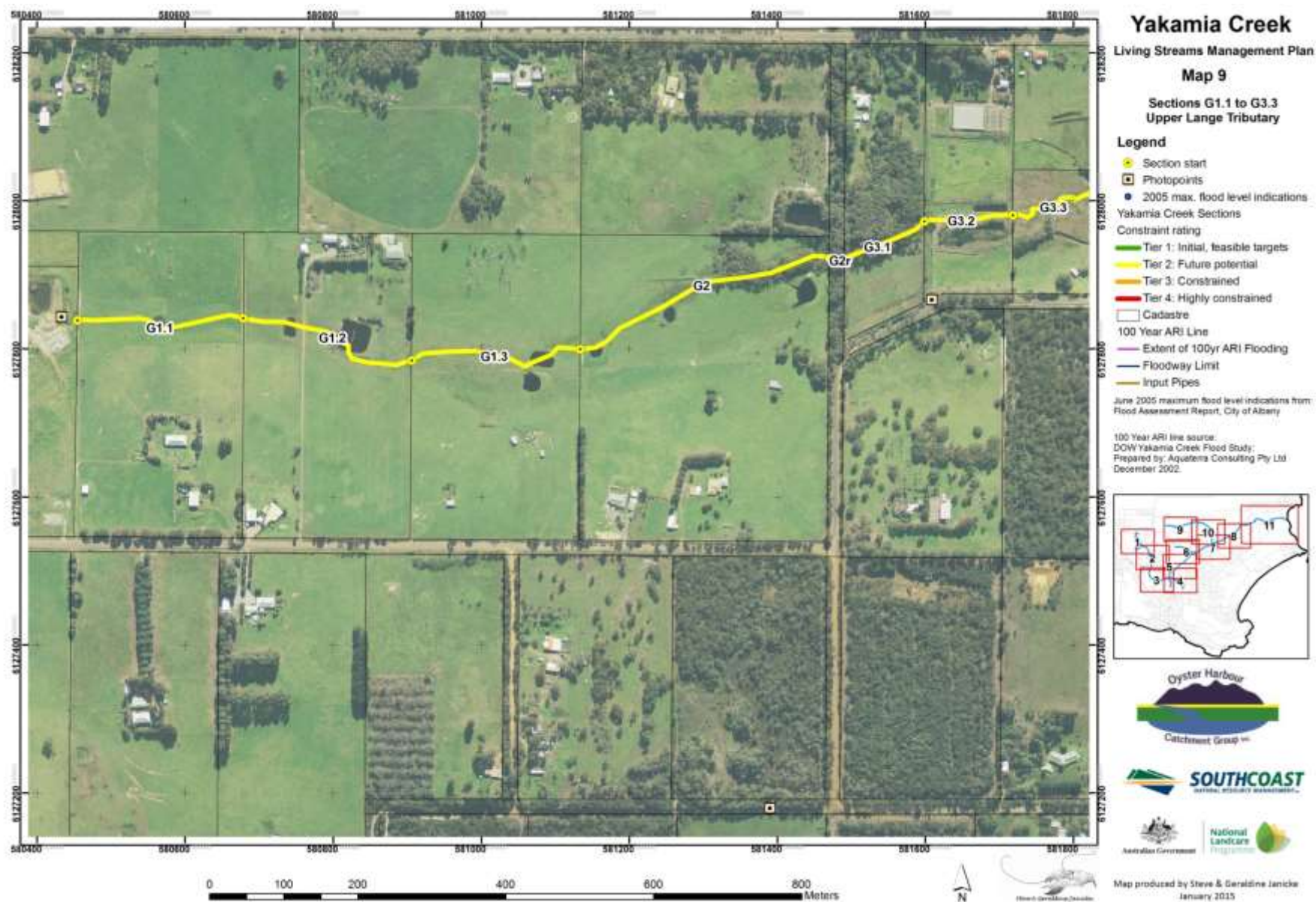
Yakamia Creek Living Stream Management Plan



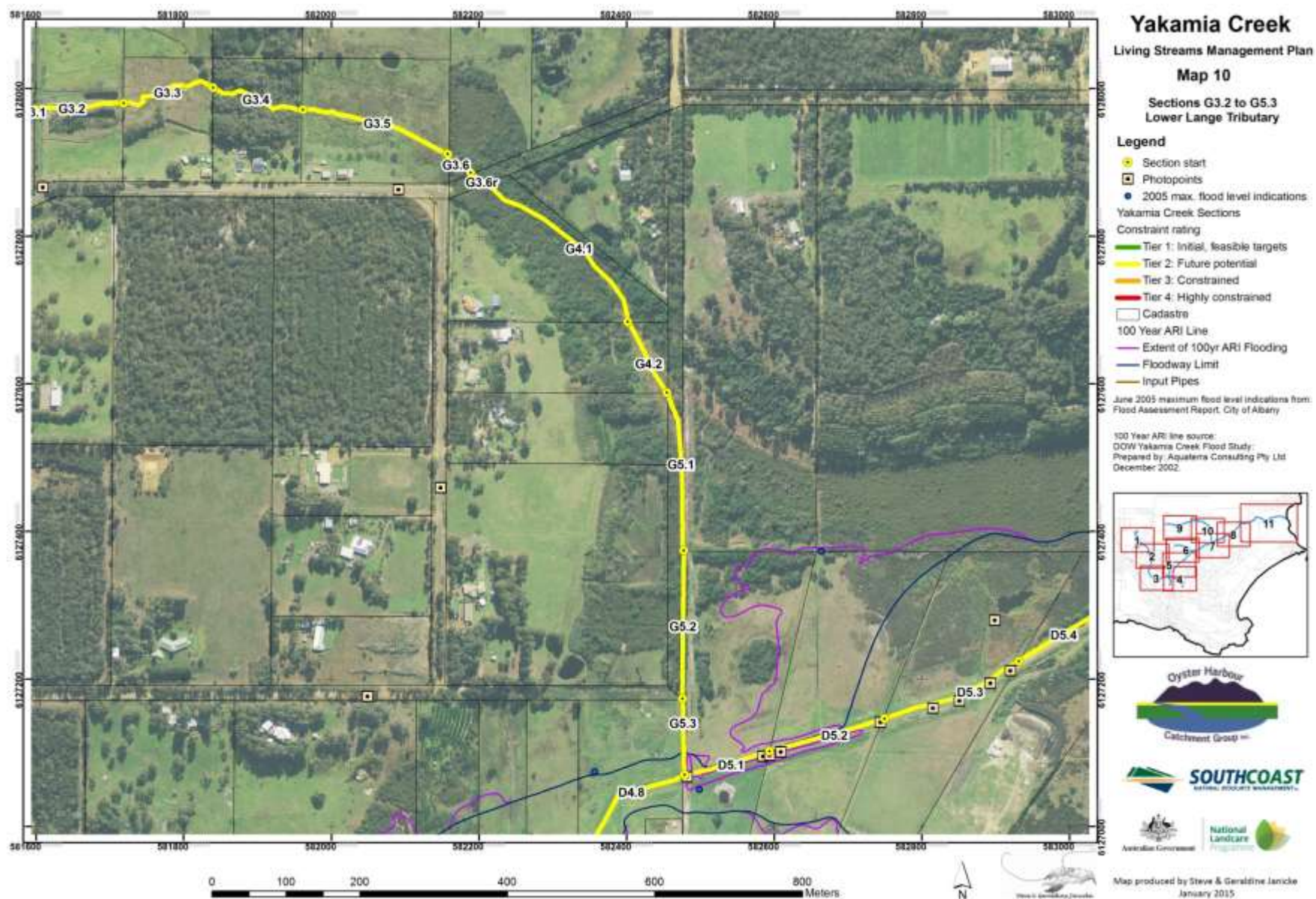
Yakamia Creek Living Stream Management Plan



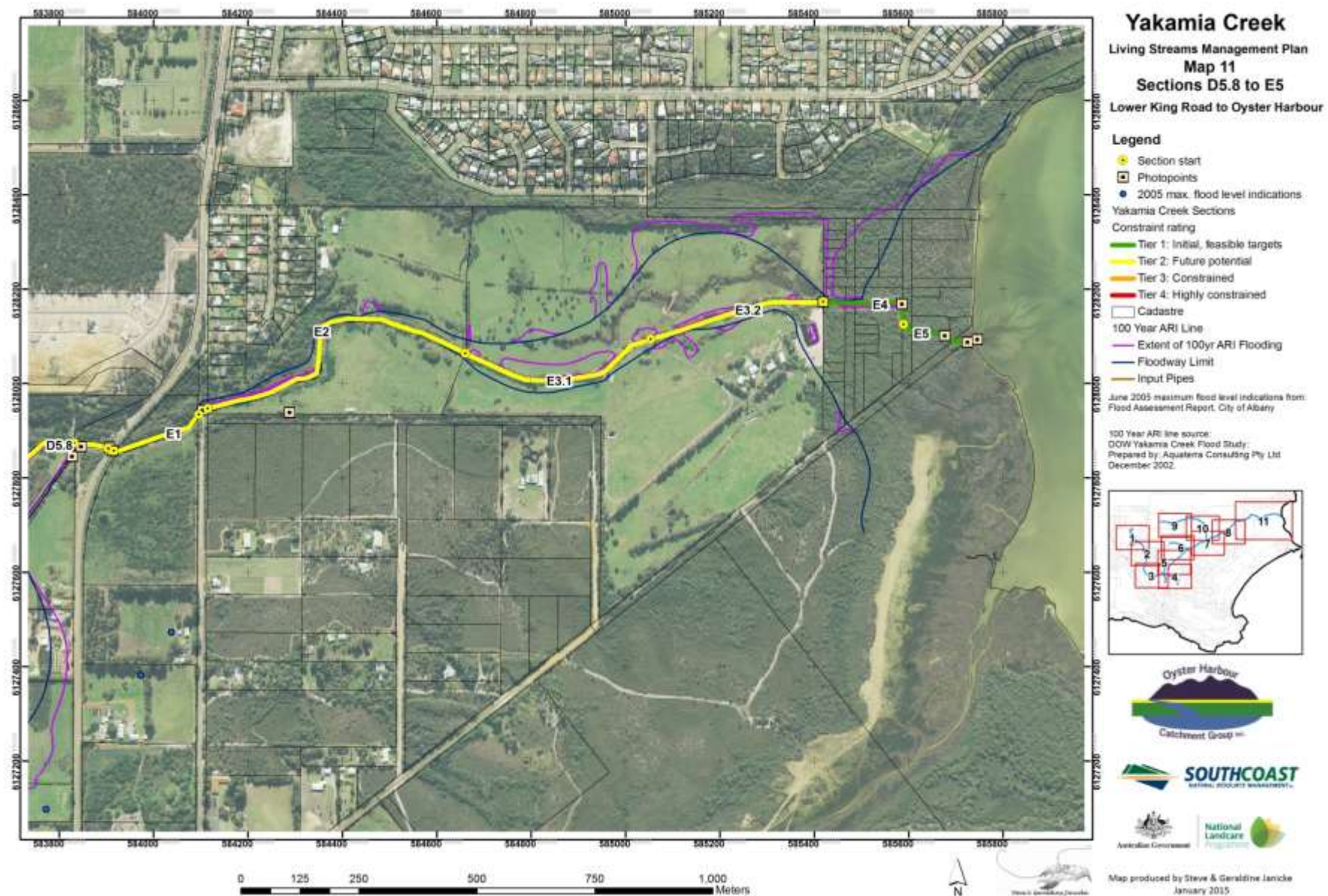
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APPENDIX 3: Use of Unmanned Aerial vehicles

Ecosystem management and change monitoring – a trial study at the Western End of Centennial Park Sporting Precinct.

In 2014, a trial use of an Unmanned Aerial Vehicle (UAV) was undertaken to look at its capacity to provide detailed ecosystem mapping. The UAV incorporated 'Point Cloud' photographic technology.

The process of taking a broad concept plan and creating an accurate working plan of an area requires greater detail of ecosystem features in the target area. In the case of stream rehabilitation or restoration, accurate cross-sections and bed slopes provide the essential data for determining the primary hydraulic characteristics of the floodway. These are usually obtained by on-ground surveying methods. The data also enables an analysis of the likely hydraulic impacts of any proposed modifications.

However, the other components of the ecosystem, chiefly vegetation, habitat structure, micro-topography and so on, are more difficult and costly to survey in detail. As a result soft engineering has had to rely on less rigorous mapping techniques, essentially adding further site observations to a base concept plan. Rehabilitation sites are often too small for standard aerial images to be of more than general usefulness in this respect, although technical improvements are raising the standard of image resolution.

The recent and rapid development of remote sensing equipment with high-resolution imagery offers a tool for the urban ecologist to create working plans at a level comparable with traditional surveying methods, but with greater detail. This can be used to model various project scenarios.

Airborne laser scanning offers foundation mapping of the 'bare-earth' micro-topography to less than decimetre (100 mm) accuracy even under vegetation cover. The structure of the vegetation cover can also be mapped. Digital multi-spectral imagery tools offer a way of mapping the health and vigour of vegetation and to assess changes over time. Specialised data such as thermal imaging, canopy mapping and shading models offer tools to monitor environmental functions and to track changes in the target area over time.

Remote assessment technology incorporated into UAV's is proving to be useful for smaller areas and is well suited to assessment of complex areas such as the riparian zone. It is also fast becoming very cost effective.

Figure 1 shows a high resolution image spanning sections C1 – C2 – C3 of Yakamia Creek that was photographed from an Unmanned Aerial Vehicle (UAV). The insert indicates the vastly improved level of aerial image resolution that can be obtained.

Figure 2 shows a Digital Elevation Model (DEM) of the same area emphasizing the canopy height of remnant vegetation and topography of the cleared area.

Yakamia Creek Sections C1 – C3



Figure 1: High resolution image spanning sections C1 – C2 – C3 of Yakamia Creek with insert showing the improved level of image resolution.

Yakamia Creek Sections C1 – C3

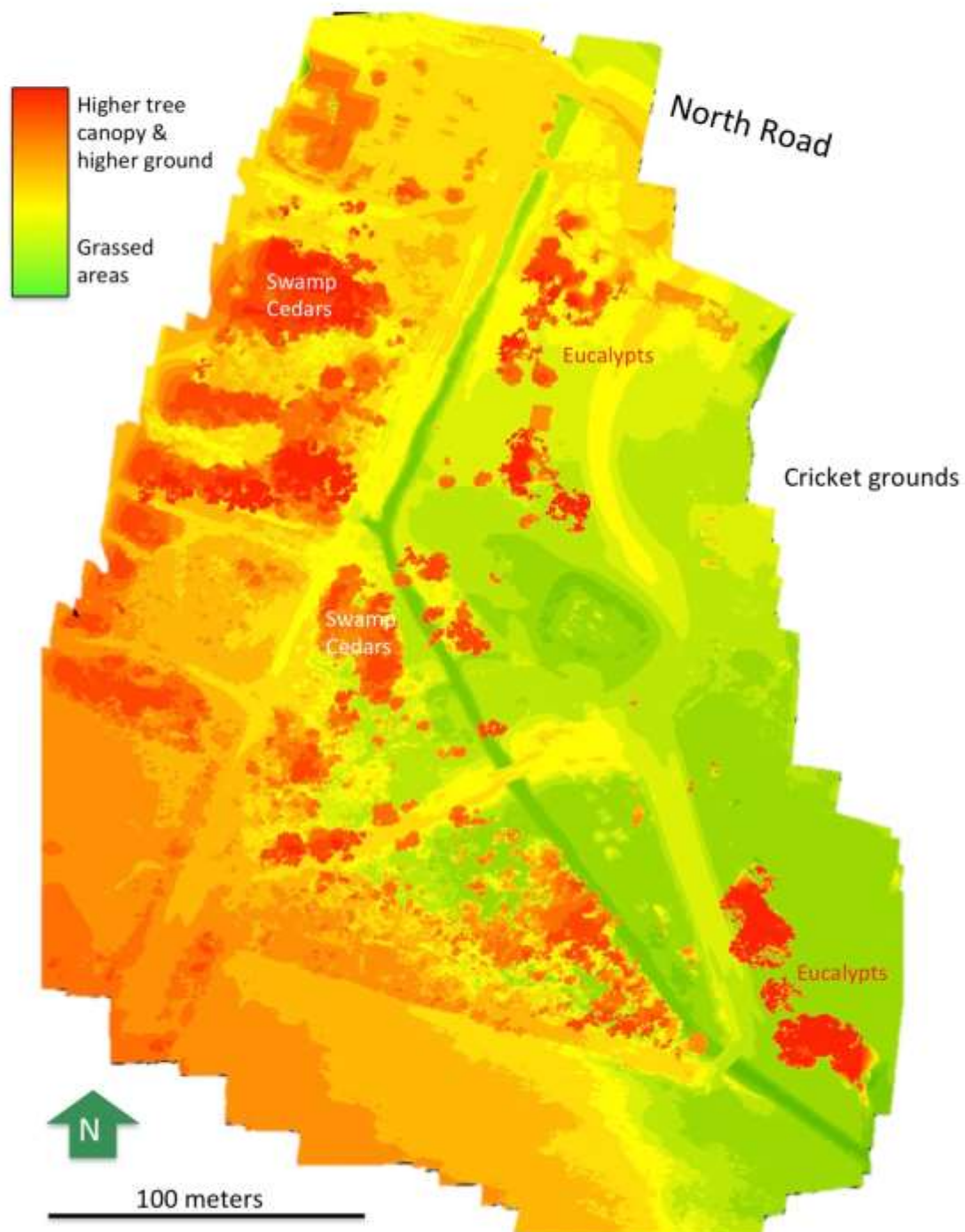


Figure 2: Digital Elevation Model (DEM) of sections C1 – C2 – C3 of Yakamia Creek emphasizing the canopy height of remnant vegetation and topography of the cleared area.