



Woodstock Environmental Offset Project Stage 2

Annual Progress Report 2023

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*Report prepared for Budadee Aboriginal Corporation and The Department of Water
and Environmental Regulation*

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We acknowledge the Traditional Owners and custodians of country throughout Australia and their continuing connection to land, waters, and community. We pay our respects to the people, the cultures, and the Elders past, present and emerging.

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1. PROJECT BACKGROUND

For full Project Background refer to the Tharra Rehabilitation Plan: Weed Control Plan.

Since 2021, Budadee Aboriginal Corporation (BAC) in partnership with Terra Rosa Consulting (TRC), have undertaken environmental planning, monitoring and rehabilitation works across the Woodstock Abydos Protected Reserve (WAPR), as a part of the Woodstock Environmental Offset Program (WEOP). The objective of the Woodstock Environmental Offset Program, funded by the Pilbara Environmental Offset Fund (PEOF), is to enhance environmental health of *Tharra* (the Traditional name of the Palyku Native Title Determination Area within the WAPR), based on both cultural and conservation values.

BAC's ranger team identified introduced weed species as a priority threat to the environmental and cultural values of the WAPR, and management of priority weed species was targeted as the focus for the WEOP. A staged implementation strategy was designed. Stage 1 (2021) focussed on collecting information to inform future weed management actions within the riparian zones in Tharra, the exchange of botanical knowledge between Traditional Owners and scientists, and to inform the design of a vegetation monitoring approach and riparian weed control plan (the *Tharra Rehabilitation Plan: Weed Control Plan [the Plan]*). During Stage 1, rubber tree (*Calotropis procera*) was identified as the primary weed species of concern for Budadee. A recent introduction into the central Pilbara, *Calotropis* has increased rapidly in density and distribution, and directly threatens the rich environmental and cultural values of Tharra. *Calotropis* particularly threatens the riparian zones of the reserve, whose waters hold particularly strong value to Palyku people.

The main objective for Stage 2 of the WEOP (2022 – 2023) is to implement the Plan as drafted in Stage 1. The key objective of the Plan is the improvement in condition of at least 1000 ha of vegetation within Tharra. The specific objectives of the Plan are as follows:

- Implement a targeted *Calotropis procera* management program, informed by field observations collected during Stage 1 and Traditional Knowledge and values;
- Continue mapping the distribution of weeds within the riparian zones of Tharra, to track the progress of targeted weed control program;
- Collect vegetation condition assessment data within the riparian zones of Tharra, including *Calotropis procera* density estimations, in line with established Monitoring and Evaluation Framework methodology;
- Further improve the capacity of the Budadee Ranger team to conduct rehabilitation and monitoring activities as per DWER's Monitoring and Evaluation Framework; and
- Facilitate leadership from Traditional Owners in the delivery of the above objectives, ensure that Traditional Knowledge and values influence decision-making, and that cultural protocols are observed on country.

Upon direction from DWER's PEOF Team, two of the above objectives were postponed to better align with DWER's Vegetation Monitoring Framework (under development). The postponed objectives are denoted with an asterisk.

2. PROJECT LOGIC

For full Project Logic refer to the Tharra Rehabilitation Plan: Weed Control Plan.

Budadee operates on a Caring-for-Country model. Leadership from Traditional Owners is integrated into the planning and delivery of all work programs, including the WEOP, to ensure Traditional Knowledge and values influence decision making and cultural protocols are observed while on country. The collaboration and exchange of knowledge between Traditional Owners and environmental consultants ensures that management strategies provide the best outcomes culturally and ecologically.

The objectives and trip timing outlined in the Plan were adapted due to the development of DWER's Vegetation Monitoring and Evaluation Framework, accommodation availability, heavy rainfall events and logistical considerations.

This document reports on the outcomes of works conducted in 2023 in accordance with the Plan. Specifically weed surveys, mapping, and control efforts as per the second year of Stage 2.

2023 Field Trips

Five on-country field trips were held between June and November 2023 (see *Table 1*). These field trips focused on targeted *Calotropis* surveys and control within the riparian areas of the WAPR. Opportunistic mapping of non-target weed species was conducted alongside the targeted survey efforts to contribute to Budadee's weed distribution dataset. Delivery of accredited training in relevant Conservation and Ecosystem Management (Certificate III) units were conducted alongside on-country works to improve the capability of the ranger team.

The specific objectives of the five on-country field trips were as follows:

- Conduct targeted *Calotropis* surveys within the riparian areas of Tharra;
- Control all *Calotropis* plants encountered during the targeted surveys, and record the number of juvenile and mature *Calotropis* individuals encountered and controlled;
- Map the distribution of *Calotropis* within the riparian areas of Tharra;
- Continue to conduct broad-scale mapping of non-target weed species during the targeted survey effort; and
- Improve the capacity of the Ranger team to carry out rehabilitation and monitoring activities.

Table 1: Project participants and trip dates.

Project participants				
Trip 1	Trip 2	Trip 3	Trip 4	Trip 5
1st – 6th June 2023	10th – 14th July 2023	14th – 18th August 2023	10th – 15th October 2023	6th – 11th November 2023
Stephen Stewart Jnr.	Biddy Norman	Gavin Cabales**	Gavin Cabales**	Gavin Cabales**
Annabel Stream*	Gavin Cabales**	Walter Stream**	Biddy Norman	Annabel Stream*
Duane Stream*	Walter Stream**	Kevin Stream Snr.**	Stephen Stewart Jnr.	Zakiesha Clinch*
Zakiesha Clinch*	Margaret Stewart	Fred Stream	Margaret Stewart	Diana Flanagan
Brandon Dhu	Stephen Stewart Jnr.	Hazel Lockyer	Natalie Stream	Keniesha Cabales
Diana Flanagan	Stanley Ball Jnr.	Stephen Stewart Jnr.	Damien Ball*	Sandra Francis
James Dolin* (Budadee Ranger Coordinator)	Amanda Stream	Natalie Stream	Michael Coffin*	Leroy Clinch
Danika Penson (Terra Rosa)	Brandon Dhu	Kevin Stream Jnr.	Zakiesha Clinch*	Stan Ball Jnr.
	Leroy Clinch	Jackie Hall	Annabel Stream*	Drew Hatswell (Terra Rosa)
	Robert Kelly	Annabel Stream*	Duane Stream*	Judith Giraldo* (Terra Rosa)
	Annabel Stream*	Ethan Fernleigh*	James Dolin* (Budadee Ranger Coordinator)	
	Michael Coffin*	Keniesha Cabales	Danika Penson (Terra Rosa)	
	Zakiesha Clinch*	Drew Hatswell (Terra Rosa)	Maddison Fraser (Work experience student)	
	Ethan Fernleigh*	Danika Penson (Terra Rosa)		
	James Dolin* (Budadee Ranger Coordinator)			
	Danika Penson (Terra Rosa)			

*Participation in this project funded in-kind through Budadee's Aboriginal Ranger Program.

**Senior Ranger salaries funded by Budadee Aboriginal Corporation.

The following additional personnel contributed to trip outcomes, throughout the course of the 2023 works, through participation in vehicle surveys and *Calotropis* control works:

- Natalie Stream (*Trip 1*)
- Damien Ball (*Trip 1*)
- Amanda Stream (*Trip 1 and 5*)
- Michael Coffin (*Trip 1*)
- Ethan Fernleigh (*Trip 1*)
- Sandra Francis (*Trip 1*)
- Terryanne Aspro (*Trip 1*)
- Robert Kelly (*Trip 1*)
- Leroy Clinch (*Trip 1*)
- Fred Stream (*Trip 4*)
- Stephen Stewart Snr. (*Trip 4 and 5*)
- Weston Stream (*Trip 4*)
- Hazel Rae Lockyer (*Trip 4*)
- Keniesha Cabales (*Trip 4*)
- Stephen Stewart Jnr. (*Trip 5*)
- Leo Cabales (*Trip 5*)
- Kylie Ryan (*Trip 5*)

Field Methodology

Targeted *Calotropis* survey and control works

Stage 2 of the WEOP was focussed on follow-up control of known *Calotropis procera* infestations and extending the survey area to map and opportunistically control new infestations. In 2023, this survey effort included the three major river systems within the Woodstock Abydos Protected Reserve: the Yule River, Turner River, and Shaw River. The following riparian zones within the Yule River system were subject to surveys: Yule River (main body), Yule River tributaries, Coorong Creek, Coorong Creek tributaries, Coonarie Creek, and Two Camel Creek (a tributary of Coonarie Creek). Within the Shaw River system, targeted surveys were undertaken within Tambourah Creek and Tambina Creek, while within the Turner River system, surveys were undertaken in the main body of the Turner River.

Targeted *Calotropis* surveys were undertaken through light vehicle and on-foot reconnaissance as appropriate. The use of two off-road buggies (contributed in-kind by Senior Rangers Kevin Stream Snr. and Walter Stream) facilitated access to previously inaccessible riparian areas. All *Calotropis* individuals encountered during these targeted surveys were recorded and controlled as per established methodology, with a distinction being made between juvenile and mature *Calotropis* plants when collecting field data. Broad scale weed mapping was conducted alongside targeted *Calotropis* survey works, with a focus on capturing any changes in non-target weed distribution within WAPR, and mapping previously unrecorded areas. Individual instances of non-target weed species were collected as point data using the QuickCapture App.

The field data collection methodology was as follows:

- Track logs recorded on three handheld GPS units;
 - “GPS 1” recording from the start of the workday until the end (Total Survey Route),
 - “GPS 2” recording while within riparian areas (Targeted Survey Effort),
 - “GPS 3” recording in areas where *Calotropis* is present (*Calotropis* distribution).
- The number of juvenile and mature *Calotropis* individuals within each occurrence area were counted and recorded; and
- Non-target weed species distribution was recorded as point data using the ArcGIS application QuickCapture.

Multiple GPS units were used to record the distribution of *Calotropis procera*, targeted survey effort and all movements within the WAPR. At the start of the workday, *GPS 1* was turned on to record the Survey Route, and when entering riparian areas *GPS 2* was turned on to document the Targeted Survey Effort. When a *Calotropis* plant or infestation (multiple *Calotropis* plants in the same area) was observed, the location of the plant or extent of the infestation was recorded as a track log on *GPS 3*, the number of juvenile and/or mature plants was recorded along with any observations in a field notebook and the plant(s) were controlled by the ranger team.

Small *Calotropis* individuals or plants growing in loose, sandy soil were pulled out by hand, and larger *Calotropis* plants were controlled using the ‘cut and paint’ method. The ‘cut and paint’ method entails severing trees at their base, using either loppers

or saws, and immediately 'painting' the stump with the gel herbicide Vigilant® II. Herbicide was applied to *Calotropis* plants within 5 seconds of cutting to ensure uptake through the plants vascular system (Campbell et al. 2015). Vigilant® II herbicide (active ingredient 4.47 g/L aminopyralid, 44.7 g/L picloram) was used as it has been shown to be the most effective control method (Jo Williams, Pilbara Mesquite Management Council, 2021 on-country training). Vigilant® II herbicide is recommended by the Department of Agriculture and Fisheries for control of *Calotropis procera* in areas of native vegetation (DAF, 2020).

2023's field methodology, described above, is the same as 2022's methodology with the addition of distinguishing between juvenile and mature plants when recording *Calotropis* individuals in the field. The collection of this additional information allows for assessing the success of previous control efforts, by distinguishing plants which likely emerged from the seedbank following previous control works and plants which have persisted despite control efforts. When recording this data, *Calotropis* individuals are classified as "mature" plants if they met at least one of the following criteria:

- Plants bearing flowers;
- Plants bearing fruit or old seed pods;
- Plants with woody stems; and/or
- Plants which have regrown following control (i.e. living plants possessing a previously cut stump).

Calotropis plants not possessing any of the above characteristics were classified as "juvenile".

Plate 1: Targeted Calotropis surveys being conducted in light vehicles.



Plate 2: A juvenile Calotropis plant growing in the Coorong Creek.



Plate 3: Ranger Keniesha Cables (front) ready to apply Vigilant herbicide as Senior Ranger Gavin Cables (behind) uses loppers to cut a Calotropis plant at its base.



Broad-scale opportunistic weed mapping

Opportunistic weed mapping of non-target species was conducted alongside targeted *Calotropis* surveys. Broad-scale mapping of non-target weed species was conducted during light vehicle reconnaissance or on-foot surveys, as the terrain allowed. Instances of non-target weeds were identified and recorded as point data (presence/absence data) using QuickCapture (ArcGIS). As there was significant overlap in survey area coverage with previous years, opportunistic weed mapping data was compared to previous mapping data, and new points were only collected when surveying new areas, identifying new populations, or where significant change had occurred from previous years.

Plate 4: Ranger Michael Coffin (L) using QuickCapture to map *Aerva javanica* distribution (non-targeted species) and Ranger Stan Ball Jnr. (R) tallying *Calotropis* plants.



Data Analysis

During the 2021 reconnaissance surveys, it was observed that *Calotropis procera* occurrence was not uniform throughout riparian zones of Tharra. There were significant differences in occurrence in the northern (Turner) and southern (Yule and Shaw) river systems, and plants tended to occur in discrete patches as either single immature plants (saplings) or as discrete concentrated populations containing mature (flowering and/or woody-stemmed plants) and immature plants. To quantify these patterns of distribution across the WAPR, densities of *Calotropis procera* were calculated on a river system scale (landscape) and local infestation scale (site-specific).

On a river system (landscape) scale, riparian zones were categorised by river system (Yule River, Yule River tributary etc). The relative density of each river system was calculated as the number of *Calotropis* plants per kilometre of creekline (i.e. total number of *Calotropis* plants per river system/total length (km) of targeted survey effort).

On a local infestation scale (site specific), occurrences of *Calotropis* were classified as discrete locations if they were more than 200 metres from the next nearest *Calotropis* individual. In 2022, eighteen discrete locations were recorded to have *Calotropis* present, and each location was assigned a code following the formula of either XTY or XY; with X = initial of the creekline, for instance T for Turner River, C

for Coorong Creek; T = denotes location is within a tributary of the main creekline; and Y = number assigned to the location. Locations were numbered from north to south for Turner River and west to east for all other creeklines (refer to *Appendix 1, Map 4* for labelled map of discrete locations). The discrete occurrence location codes assigned in 2022 remained the same for 2023. Twelve new occurrence locations were recorded in 2023, and these new locations were assigned a code using an adaptation of the formula above: N_XY. With X and Y representing, as above, the initial of the creekline and the number assigned to the location respectively; and with "N_" denoting the location was a newly recorded location (recorded in 2023 but not in previous years). The newly recorded occurrence locations were numbered following the same conventions utilised in 2022, as detailed above.

To assess patterns of infestation density at a local, site-specific scale, density was calculated for each discrete location as the number of *Calotropis* plants per kilometre of creekline (i.e. total number of *Calotropis* plants/total length (km) of *Calotropis* extent). Each discrete location was assigned a relative density class based on the calculated density. The five density classes are: <1 plant per km; 1-100 plants per km; 100-500 plants per km; 500-1000 plants per km and 1000 plants per km. These density classes were calculated to enable visual representation of densities across discrete locations within the WAPR and to assess priority areas for follow-up control.

For each discrete *Calotropis* occurrence location recorded in 2023, a relative age score was calculated. This score represents the proportion of mature individuals within a discrete occurrence location. An age score of 0 indicates an infestation is comprised of only juvenile plants (i.e. 0% of plants were mature), and an age score of 1 indicates an infestation is comprised of only mature plants (i.e. 100% of plants were mature).

Additionally, a hectare density rate measured as *Calotropis* plants per hectare was calculated for each occurrence location. This was calculated using *Calotropis* count data and infestation area in hectares (calculated on QGIS using satellite imagery, *Calotropis* extent data (GPS 3) and area measurement tools). For occurrence locations with infestation extents less than 1 hectare, hectare density rates were rounded up to 1 hectare, to avoid skewing the dataset. The hectare density rate was calculated to allow for assessment of the infestation densities within WAPR compared to the national scale (Campbell et al. 2015, Menge et al. 2016).

As the field data collection methodology has been refined over the project to ensure collection of accurate and comprehensive field results, there are some limitations in comparing some measures between years. For instance, the *Calotropis* surveys conducted in 2021 were undertaken opportunistically alongside vegetation monitoring works hence the number of *Calotropis* within a survey area was sometimes not estimated (such as in Coorong Creek). Additionally, only the total number of *Calotropis* plants were recorded in 2021 and 2022, whereas in 2023 a distinction was made between juvenile and mature plants when collecting field data.

3. FIELD RESULTS

Broad-scale opportunistic weed mapping

Broad-scale weed mapping was conducted opportunistically as light vehicle reconnaissance and on-foot surveys over five on-country trips at Tharra. The total survey route for 2023 was 2052.6 km, which included all movements within the WAPR during field work. Observed instances of weeds were recorded as point data using the ArcGIS application Quick Capture. Weeds were not recorded at areas previously surveyed in 2021 and 2022 unless a notable change was observed (new growth of *Calotropis* for example). This point data indicates the presence of a weed species in the location of the record but is not representative of the total number of individuals encountered.

Seven weed species were mapped, across a total of 253 observations within Tharra (refer to *Appendix 1, Map 5*). The most frequently recorded species was *Cenchrus ciliaris* (128 observations) followed by *Calotropis procera* (58 observations), *Vachellia farnesiana* (32 observations) and *Aerva javanica* (25 observations) (see *Table 2*). One new species was recorded compared to 2022 (*Argemone ochroleuca*, 2 observations). Mexican Poppy (*Argemone ochroleuca*) was flagged as a weed species of concern by Senior Ranger Kevin Stream Snr. due to its rapid invasion within rivers around Marble Bar.

Table 2: Weed species and observation frequency recorded in the WAPR in 2023.

Introduced species	Observations
<i>Aerva javanica</i>	25
<i>Argemone ochroleuca</i>	2
<i>Calotropis procera</i>	58
<i>Cenchrus ciliaris</i>	128
<i>Chloris virgata</i>	7
<i>Flaveria trinervia</i>	1
<i>Vachellia farnesiana</i>	32

*Plate 5: Introduced species Mimosa Bush (*Vachellia farnesiana*) growing north of Coorong Creek. Photo taken in October 2023.*



Targeted *Calotropis* surveys and control

Targeted *Calotropis* surveys were undertaken upon entering riparian areas within Tharra, and separate track logs were recorded to quantify survey effort and estimate density of *Calotropis* within each river system. In 2023, targeted *Calotropis* surveys were undertaken within the riparian zones of the three main river systems with catchments within the WAPR: the Yule River, Turner River, and Shaw River.

Within the Yule River system, the following riparian zones were subject to targeted *Calotropis* surveys: Yule River (main body), Yule River tributaries, Coorong Creek, Coorong Creek tributaries, Coonarie Creek, and Two Camel Creek (a tributary of Coonarie Creek). Within the Shaw River system, targeted surveys were undertaken within Tambourah Creek and Tambina Creek (outside of WAPR). Within the Turner River system, targeted surveys were undertaken in the main body of the Turner River.

Riparian areas were surveyed in light vehicle and on-foot, and all *Calotropis* plants encountered were recorded and controlled using established methodology (refer to *Appendix 1, Map 1* for map of survey effort). A total of 191.5 km of targeted survey effort within riparian zones was recorded over the five on-country trips in 2023 (see *Table 3*).

Table 3: Targeted Survey Effort (km) recorded by riparian zone in 2023.

Riparian Area	Survey Effort (km)
Yule River System	TOTAL: 162.2 km
Yule River (main)	63.1
Yule River Tributaries	64.7
Coorong Creek (main)	11.2
Coorong Creek Tributaries	16.6
Coonarie Creek	4.0
Two Camel Creek	2.5
Turner River System	TOTAL: 19.1 km
Turner River	19.1
Shaw River System	TOTAL: 10.3 km
Tambina Creek	1.0
Tambourah Creek	9.3

A total of 1137 *Calotropis* plants were controlled in 2023; 740 juvenile plants and 397 mature plants (refer to *Appendix 1, Map 1* for a map of *Calotropis* control locations). As observed in previous years, *Calotropis procera* density varied significantly between the upper catchment systems of the Turner River and the upper catchment systems of the Yule River (Yule River, Coorong Creek, Coonarie Creek, and associated tributaries) and the Shaw River (see *Table 4*).

The majority of *Calotropis* plants recorded in 2023 were within the Turner River; with a total of 974 *Calotropis* plants recorded and controlled in the main body of the Turner River (648 juvenile plants; 326 mature plants) (relative density of 51 plants per km). In comparison, 163 *Calotropis* were controlled within the Yule River (main body) (relative density of 1.8 plants per km), and 56 *Calotropis* plants were recorded within

the Coorong Creek (relative density of 5 plants per km). No *Calotropis* plants were recorded within the Shaw River. There was a higher proportion of juvenile *Calotropis* plants within the Turner River (relative age score of 0.33) and Coorong Creek (relative age score of 0.30) in comparison to the Yule River (main body) (relative age score of 0.50).

Table 4: Total count and relative density of *Calotropis procera* plants controlled in riparian areas of WAPR in 2023.

Creekline	Number of <i>Calotropis procera</i>			Relative density (plants/km)	Relative age score
	TOTAL	Juvenile	Mature		
Yule River system	163	92	71	1.4	0.44
Yule River (main)	107	53	54	1.8	0.50
Yule River Tributaries	-	-	-	-	-
Coorong Creek	56	39	17	4.9	0.30
Coorong Creek Tributaries	-	-	-	-	-
Coonarie Creek	-	-	-	-	-
Two Camel Creek	-	-	-	-	-
Turner River system	974	648	326	51	0.33
Turner River (main)	974	648	326	51	0.33
Shaw River system	0	0	0	-	-
Tambourah Creek	-	-	-	-	-
Tambina Creek	-	-	-	-	-

Discrete *Calotropis* occurrence locations

During this year's targeted surveys, *Calotropis* plants were recorded at a total of 17 discrete locations within the WAPR: four locations within the Turner River; 10 within the Yule River, and three within the Coorong Creek (see *Table 5*). Eleven of the occurrence locations were newly identified in 2023 (nine in the Yule River, one in the Coorong Creek and one in the Turner River), and six of these discrete locations were previously recorded during the 2022 works.

Table 5: Number of Calotropis occurrence locations within riparian areas of WAPR in 2023.

Creekline	<i>Calotropis</i> occurrence locations		
	TOTAL	Previously recorded locations	Newly identified locations
Yule River	10	1	9
Coorong Creek	3	2	1
Turner River	4	3	1

Each discrete location was assigned a code and *Calotropis* density was calculated for each location as per plants per km of creekline and plants per hectare (see *Project Logic, Data Analysis Methodology*). Site-specific density rates ranged from <1 plant per km to 634 plants per km across the 17 discrete locations within the WAPR (refer to *Appendix 1, Map 4* for labelled map of discrete locations and relative densities). All locations with a density rate of <1 plant per km are locations with a single *Calotropis* individual.

The locations with the highest density rates were site T7 (634 plants per km of creekline), followed by site N_Y1 (382 plants per km), site N_Y7 (248 plants per km) and site N_C1 (211 plants per km). All other discrete locations recorded density rates less than 100 plants per km. The hectare density rates of the four most dense occurrence locations were ~61 plants/ha at site T7, ~44 plants/ha at site N_Y1, ~27 plants/ha at site N_C1 and ~20 plants/ha at site N_Y7 (see *Table 6*).

At site T7 (south of Pulkunuh Spring) a high instance of re-shooting following control was observed, with majority of the mature *Calotropis* plants within this dense infestation having regrown from cut stumps (previously controlled in 2021 and 2022). Re-shooting of plants following control was observed very infrequently at other locations within the reserve.

Table 6: Total number of *Calotropis procera* individuals, site-specific density rates and relative age score of discrete occurrence locations within WAPR in 2023.

	Number of <i>Calotropis procera</i> plants			Site-specific density rate (plant/km)	Site-specific density rate (plants/ha)	Relative age score
Location Code	TOTAL	Juvenile	Mature			
Yule River						
Y1	6	6	-	<6	6	0
N_Y1	47	12	35	382	43.9	0.74
N_Y2	1	1	-	<1	1	0
N_Y3	11	11	-	6.9	0.6	0
N_Y4	1	1	-	<1	1	0
N_Y5	1	1	-	<1	1	0
N_Y6	1	1	-	<1	1	0
N_Y7	34	20	14	248	20.0	0.41
N_Y8	2	1	1	<2	2	0.50
N_Y9	4	-	4	<4	4	1
Coorong Creek						
C1	1	1	-	<1	1	0
C2	2	-	2	<2	2	1
N_C1	52	37	15	211	26.9	0.29
Turner River						
T1 & T2	61	48	13	69	5.7	0.21
T3	43	38	5	55	4.6	0.12
T7	824	528	296	634	61.0	0.36
N_T1	46	34	12	94	7.5	0.26

The relative age score was calculated for each discrete *Calotropis* occurrence location recorded in 2023, an age score of 0 indicates an infestation is comprised of only juvenile plants, and an age score of 1 indicates an infestation is comprised of only mature plants. The occurrence locations with the greatest proportion of mature plants were sites N_Y9 and C2 (relative age scores of 1 at both sites), followed by site N_Y1 (relative age score of 0.74) (see Table 6). Seven discrete occurrence locations had a relative age score of 0: sites Y1, N_Y1, N_Y2, N_Y3, N_Y4, N_Y5, N_Y6, N_Y7, N_Y8, N_Y9 and C1.

Comparison to previous years' results

Since *Calotropis* survey and control works commenced within the WAPR in 2021, there has been a decrease in the number of *Calotropis* plants recorded and controlled each year. In 2021, approximately 2711 *Calotropis* plants were controlled within WAPR; 1424 *Calotropis* plants were controlled in 2022 and 1137 *Calotropis* plants were controlled in 2023 (see Table 7). In all years, majority of the *Calotropis* plants recorded have occurred within the Turner River, with approximately 2670 *Calotropis* plants controlled in 2021; 1211 *Calotropis* plants in controlled 2022; and 974 plants were controlled in 2023. There was an increase in the targeted survey effort (km) recorded in 2023, with 106.2 km of survey effort recorded in 2022 and 145.4 km of survey effort recorded in 2023.

Table 7: Number of *Calotropis* plants, targeted survey effort (km) and number of discrete occurrence locations recorded in riparian areas of WAPR in 2021-2023. Yule River refers to main creekline and tributaries; Coorong Creek refers to main creekline and tributaries.

	2021	2022	2023
	Number of <i>Calotropis</i> plants		
WAPR	~2711	1424	1137
Yule River	41	8	107
Coorong Creek	<i>Not estimated</i>	46	56
Turner River system	2670	1370	974
	Targeted Survey Effort (km)		
WAPR	<i>Not estimated</i>	106.2	145.4
Yule River	<i>Not estimated</i>	59.9	81.7
Coorong Creek	<i>Not estimated</i>	23.7	27.8
Turner River system	<i>Not estimated</i>	22.6	19.1
	Number of discrete occurrence locations		
WAPR	26	18	17
Yule River	4	4	10
Coorong Creek	5	5	3
Turner River system	17	9	4

In 2023, an increase in the number of *Calotropis* individuals recorded in both the Yule River (8 *Calotropis* plants in 2022, 107 plants in 2023) and the Coorong Creek (43 *Calotropis* plants in 2022, 56 plants in 2023) was observed. These increases reflect the expansion of targeted surveys to new areas within these creeklines, and the subsequent identification of previously unrecorded *Calotropis* occurrence locations.

Changes in *Calotropis* density

Calotropis procera was identified and controlled at a total of 18 discrete locations within the WAPR. Thirteen of these discrete locations were resurveyed in 2023. Three of the occurrence locations recorded in 2022 (sites T5, T6 and TT1) were not resurveyed based on cultural protocols.

In 2022, site T1 and T2 were recorded as separate occurrence locations as the ~550m stretch of creekline between the two sites was not surveyed due to restricted vehicle access. In 2023, this stretch of creekline between site T1 and T2 was subject to targeted surveys and scattered *Calotropis* individuals connected the two sites, hence they have been reclassified as one occurrence location (*site T1 & T2*).

Table 8: Number of Calotropis plants controlled at discrete occurrence locations, and changes in Calotropis counts and density, within the WAPR in 2022 and 2023. '-' indicates occurrence location not surveyed in 2023.

Creekline	Location Code	Number of <i>Calotropis</i> plants			Change in density (%)
		2022	2023	Difference (2022-2023)	
Yule River	Y1	5	6	1	20
	Y2	1	0	-1	-100
	Y3	1	0	-1	-100
	Y4	1	0	-1	-100
Coorong Creek	C1	1	1	0	0
	C2	43	2	-41	-95.3
Coorong Creek Tributary	CT1	1	-	N/A	-
	CT2	1	0	-1	-100
	CT3	1	-	N/A	-
Turner River	T1 & T2	250	61	-189	-75.6
	T3	141	43	-98	-69.5
	T4	1	0	-1	-100
	T5	2	-	N/A	-
	T6	10	-	N/A	-
	T7	806	824	18	2.23
	T8	1	0	-1	-100
Turner River Tributary	TT1	159	-	N/A	-

Decreases in *Calotropis* density were observed at nine discrete locations, with the most notable reductions in *Calotropis* density observed at the following occurrence locations: site T1 & T2, T3, and C2 (see *Table 8*). A 95.3% reduction in *Calotropis* density was observed at site C2 (43 *Calotropis* plants in 2022, 2 plants in 2023); and a 75.6% reduction in density was observed at site T1 & T2 (250 plants in 2022, 61 plants in 2023). At site T3, *Calotropis* density decreased by 69.5% from 141 plants in 2022 to 43 plants in 2023 (38 juvenile plants, 5 mature plants).

4. DISCUSSION AND MANAGEMENT RECOMMENDATIONS

Opportunistic weed mapping

Broad-scale mapping of non-target weed species has been undertaken opportunistically during on-country works since the project commenced in 2021. During this period, the distribution of fourteen weed species within the WAPR have been mapped (refer to *Appendix 1, Map 5*). In 2023, six non-target weed species were mapped within the WAPR: *Aerva javanica*, *Argemone ochroleuca*, *Cenchrus ciliaris*, *Chloris virgata*, *Flaveria trinervia* and *Vachellia farnesiana*. The patterns of distribution of Buffel Grass (*Cenchrus ciliaris*) and Kapok (*Aerva javanica*) were consistent with those observed in previous years. Both Buffel grass and Kapok are relatively widespread within the WAPR, however no notable increase in density or distribution has been observed throughout the project. Feathertop Rhodes Grass (*Chloris virgata*) and Speedy Weed (*Flaveria trinervia*) were both observed infrequently in 2023, and their presence within the WAPR is currently not of concern.

Mexican Poppy (*Argemone ochroleuca*), a small annual herb which invades riparian areas, was recorded within the WAPR for the first time in 2023. Two juvenile Mexican Poppy plants were recorded and manually controlled at one location within the Yule River during the 2023 works (refer to *Appendix 1, Map 5*). Mexican Poppy was flagged as a weed species of concern in 2022 by Senior Ranger Kevin Stream Snr. who has witnessed the rapid invasion of the species in river systems around Marble Bar. This species was recorded by the Budadee Ranger team during opportunistic weed mapping works outside of the WAPR boundary in 2021 along railway infrastructure corridors. Mexican Poppy seeds remain dormant for several years making control of this species challenging (Karlsson et al., 2003), hence surveillance and control of Mexican Poppy within the WAPR will continue to be undertaken during on-country works to avoid widespread invasion.

Mimosa Bush (*Vachellia farnesiana*) has been recorded in and around Coorong Creek during opportunistic weed mapping in each year of the project (refer to *Appendix 1, Map 5*), however an increase in the number of mature plants was observed in 2023. Mimosa Bush was observed to be distributed in areas of cattle disturbance and near windmills and bores. As Mimosa Bush has the potential to form dense localised thickets, particularly within areas of heavy grazing near watercourses and windmills, this observational increase in the number of mature plants is a management concern. Control of this small Mimosa Bush population should be undertaken as a priority while localised eradication of the species is still feasible. Currently, the number of Mimosa Bush individuals within the WAPR is relatively low, making it feasible to control this small infestation in 2024 alongside other management works.

Summary of field observations and results

Targeted *Calotropis* surveys were undertaken within the three major river systems within the Woodstock Abydos Protected Reserve: the Yule River, Turner River, and Shaw River. Overall patterns of *Calotropis* distribution were consistent with those reported in 2021 and 2022, with *Calotropis* plants concentrated within two of these major river systems: the Yule River system (the main creeklines and tributaries of the Yule River, Coorong Creek and Coonarie Creek) and the Turner River system (refer to *Appendix 1, Maps 1-3*). Comparatively high levels of infestation were recorded again within the Turner River systems (north), with fewer instances of *Calotropis* within the Yule River systems (south). As the Turner River (north) is located over 10 km from the nearest points of both the Yule River and Coorong Creek (south), and there are no obvious direct vectors for seed dispersal (such as a main road or water flow) between the Yule and Turner River systems it is reasonable to consider them as two distinct *Calotropis* populations for management purposes.

Targeted *Calotropis* surveys were undertaken within the Shaw River system in 2023, specifically within the Tambina Creek and Tambourah Creek. As the extent of the Shaw River system exists largely outside of the WAPR, only 10.3 km of survey effort was recorded during 2023. Areas within the Shaw River system surveyed for *Calotropis* presence include cultural sites Tambourah Spring and Tambourah Pool, located near the south-eastern boundary of the WAPR, and the minor watercourses which form part of the upper Shaw River catchment within the WAPR. No *Calotropis* plants were observed within the Shaw River system in 2023.

As observed in previous years, the patterns of density and distribution of *Calotropis procera* varied between the Yule River and Turner River systems. *Calotropis procera* occurred in discrete infestation areas at high densities (four locations with a relative density of 51.0 plants/km, 974 plants total). Within the Yule River system, patterns of *Calotropis procera* reflected a scattered distribution, with low densities of plants occurring across a larger area (13 locations with a relative density of 1.4 plants/km, 163 plants total).

Calotropis procera populations across the reserve were comprised primarily of immature (non-flowering) plants. A slightly higher proportion of the *Calotropis* population within the Turner River system were juveniles (67%) compared to the Yule River system population (56%), with age scores for the Turner River system and Yule River system populations at 0.33 and 0.44 respectively. As short-term increases in the number of *Calotropis* plants are observed during successful control programs, differentiating between the number of juvenile and mature plants is a more reliable measure of treatment success than abundance alone.

Yule River System (Yule River, Coorong Creek, Coonarie Creek and associated tributaries)

Within the Yule River system, a total of 163 *Calotropis* plants were recorded and controlled in 2023 (107 *Calotropis* plants within the Yule River (main body) and 56 *Calotropis* plants within the Coorong Creek). No *Calotropis* plants were recorded within Coonarie Creek and its associated tributaries. An increase in the total number *Calotropis* plants recorded and controlled within the Yule River and Coorong Creek was observed, with eight plants controlled within the Yule River and 46 plants controlled within the Coorong Creek in 2022. This increase can be attributed to the increased survey effort within the Yule River system, which essentially doubled from 83.6 km in 2022 to 162.2 km in 2023, leading to the discovery of ten new *Calotropis* occurrence locations within the Yule River system in 2023.

A total of 13 *Calotropis* occurrence locations were recorded and controlled within the Yule River system in 2023. Ten occurrence locations were recorded within the Yule River (main body), nine of which were newly recorded in 2023. Three occurrence locations were recorded within the Coorong Creek, one of which was newly recorded. A reduction in the *Calotropis* density was observed at 71% of the 2022 occurrence locations resurveyed in 2023, with no *Calotropis* plants present at four of these occurrence locations.

There was a greater proportion of mature *Calotropis* plants observed within the Yule River (relative age score of 0.5) in comparison to within the Coorong Creek (relative age score of 0.3). Relative age score appears to be positively correlated with the number of newly recorded occurrence locations, suggesting that previous control efforts have been successful in decreasing the density of mature *Calotropis* plants.

Yule River (main body)

Calotropis procera was recorded and controlled at four discrete occurrence locations within the Yule River (main body) in 2022. Three of these occurrence locations were comprised of single *Calotropis* individuals in 2022, and no *Calotropis* plants were observed at these three locations in 2023. The effective control of these isolated *Calotropis* plants, undertaken in 2022, has a high pay-off as the removal of isolated plants is essential in slowing the rate of invasion across the landscape (Campbell et al. 2015). As a single mature *Calotropis* tree can establish a stand of *Calotropis* plants within 2-3 years, timely removal of isolated singletons significantly reduces the management effort required to achieve effective control of *Calotropis*.

The occurrence location within the Yule River where *Calotropis* reoccurred in 2023 was site Y1, which is located at the intersection of the Yule River with the Great Northern Highway. In 2023, six juvenile *Calotropis* plants were recorded at controlled site Y1. Reoccurrence of *Calotropis* at this location is likely the result of seed dispersal from the newly recorded occurrence location (site Y_N1), which contained mature *Calotropis* plants bearing old seed pods, on the opposite side of the highway embankment. The presence of *Calotropis* at the intersection of the Yule River and the Great Northern Highway indicates that vehicles along the highway may be acting as dispersal vectors. Additionally, heavy grazing was observed at site Y_N1 which also indicates that cattle movement may be acting as a dispersal vector.

Nine new *Calotropis* occurrence locations were recorded and controlled within the Yule River in 2023. The number of *Calotropis* plants recorded at each of these new

occurrence locations ranged from one plant to 47 plants. Four of the newly recorded *Calotropis* occurrence locations within the Yule River were comprised of a single juvenile *Calotropis* plant. The control of these isolated *Calotropis* individuals is likely to have a high pay-off as the removal of isolated plants is essential to slowing the rate of *Calotropis* invasion across a landscape (Campbell et al. 2015).

The discovery of the previously unrecorded *Calotropis* occurrence locations within the Yule River can be attributed to the increase in survey effort, facilitated largely by the use of side-by-side buggies (refer to *Access to Riparian Areas* below). The use of off-road buggies in targeted *Calotropis* survey works improved the efficiency and coverage of survey works and facilitated access to over 16 km of creekline within the Yule River which was unable to be accessed in 2022. Six of the newly recorded occurrence locations, containing a total of 96 *Calotropis* plants within the Yule River, were recorded by Senior Rangers undertaking *Calotropis* surveys on side-by-side buggies. Mature plants which had previously set seed were observed at the two most populous *Calotropis* occurrence locations, site N_Y1 (47 *Calotropis* plants, relative age score 0.74) and N_Y7 (34 *Calotropis* plants, relative age score 0.41). The discovery of these *Calotropis* stands, and the subsequent control works, is vital to minimising the spread of *Calotropis* within the Yule River.

In addition to sites N_Y1 and N_Y7, mature *Calotropis* plants were also recorded at site N_Y8 (2 plants, relative age score 0.5) and site N_Y9 (4 plants, relative age score 1). These four occurrence locations containing mature plants in 2023 are priority sites for resurveying in 2024. As recruitment of *Calotropis* individuals from the soil seed bank is anticipated to be observed following control works in areas with mature plants, follow-up surveys of these occurrence locations will be undertaken in 2024 to ensure any emergent plants are controlled before they reach maturity. Effective control of *Calotropis* at these occurrence locations is predicted to be achieved within two years and should entail minimal management effort to achieve, provided follow-up surveys and control works are undertaken annually.

Coorong Creek

A total of 55 *Calotropis* plants were recorded and controlled within the Coorong Creek in 2023, across three occurrence locations. Two of the *Calotropis* occurrence locations were previously recorded and controlled in 2022, and one occurrence location was newly recorded in 2023. A total of three *Calotropis* plants were observed at the two previously recorded occurrence locations, and the remaining 52 plants were observed at newly recorded occurrence location (site N_C1). A notable decline in *Calotropis* density following control works in 2022 was observed at site C2. The relative age score for the *Calotropis* plants recorded within the Coorong Creek during the 2023 works is 0.30.

The newly recorded *Calotropis* occurrence location, site N_C1, was comprised of 37 juvenile plants and 15 mature plants, some of which had previously fruited. The relative age score for this occurrence location was 0.29. Due to the presence of old seed pods at site N_C1, emergence of *Calotropis* plants from the soil seed bank is expected to be observed. Follow-up control should be undertaken at site N_C1 in 2024 and 2025, as a priority, to remove all emergent *Calotropis* plants and prevent replenishment of the soil seed bank. It is anticipated, based on published research and field observations, that two follow-up control treatments undertaken 12 months apart will be sufficient in eradicating *Calotropis* from this site.

In 2022, 46 *Calotropis* plants were recorded and controlled within the Coorong Creek and the Coorong Creek tributary across five occurrence locations. Four of these *Calotropis* occurrence locations were comprised of a single *Calotropis* plant, and one occurrence location, site C2, was comprised of 42 *Calotropis* individuals. In 2023, only two *Calotropis* plants were recorded at site C2, representing a 95.3% reduction in *Calotropis* density.

Large scale recruitment of *Calotropis* is likely to occur within the first 12 months following control works, however this phenomenon was not observed at site C2. The emergence of only two individuals, in the 16-month period between control works in 2022 and 2023, indicates that the *Calotropis* plants at this location were effectively controlled before replenishment of the soil seed bank could occur. As the viability of *Calotropis procera* seeds declines rapidly over the first three months, reducing to zero after 15 to 24 months of burial (Bebawi *et al.*, 2015), the presence of a viable *Calotropis* seed bank at site C2 is unlikely.

The success of the *Calotropis* control works implemented at site C2 can likely be attributed to the timely implementation of control treatments. The significant reduction in *Calotropis* density, paired with the low rate of reoccurrence, observed at site C2 following treatment in 2022 highlights the efficacy of undertaking control of *Calotropis* stands before plants reach maturity. These results also highlight the importance of continuing to undertake surveillance for *Calotropis* within the WAPR annually to facilitate control of *Calotropis* plants before they reach reproductive maturity, in turn decreasing the management effort required to achieve effective control.

Turner River System

As in previous years, the majority of *Calotropis* plants controlled within the WAPR in 2023 were located within the Turner River. A total of 974 *Calotropis* plants were recorded and controlled in 2023, 648 juvenile individuals and 648 mature plants, across four discrete *Calotropis* occurrence locations. Three of the four *Calotropis* occurrence locations were previously recorded and controlled in 2022, and one of the occurrence locations was newly recorded. Similar levels of riparian survey effort were recorded within the Turner River system in 2022 (22.55 km) and 2023 (19.1 km). The relative age score for the *Calotropis* population recorded within the Turner River during the 2023 works is 0.33. Notable declines in *Calotropis* density following control works in 2022 were observed at two *Calotropis* occurrence locations (site T1 & T2 and site T3).

In 2022, site T1 & T2 were recorded as separate occurrence locations as the ~550m stretch of creekline between the two sites was not surveyed due to restricted vehicle access. In 2023, the stretch of creekline between site T1 and T2 was subject to targeted surveys and scattered *Calotropis* individuals connected the two sites, hence they have been reclassified as one occurrence location (referred to as 'site T1 & T2'). Despite the total survey area for this occurrence location increasing, a significant decrease in the number of *Calotropis* plants was observed. The number of *Calotropis* plants at this occurrence location decreased by 75.6%, from 250 *Calotropis* plants in 2022 to 61 *Calotropis* plants in 2023. The relative age score for this occurrence location was 0.21, with 78.7% of *Calotropis* plants at this location being juveniles.

A notable reduction in *Calotropis* density was also observed at site T3 following control works in 2022. The number of *Calotropis* plants recorded at site T3 reduced by 69.5%, from 141 *Calotropis* plants in 2022 to 43 *Calotropis* plants in 2023. Of the 43 *Calotropis* plants recorded in 2023, only five plants were classified as mature and the relative age score for the site was 0.12. The significant reductions in *Calotropis* density and the low relative age score recorded at site T1 & T2, and site T3, indicate that control efforts implemented in 2022 were successful. Follow-up surveys and control of any emergent *Calotropis* plants should continue to be undertaken in 2024.

One new *Calotropis* occurrence location was recorded in the Turner River in 2023, which is site N_T1. A total of 46 *Calotropis* plants were recorded and controlled at this occurrence location (34 juvenile plants, 12 mature plants) with a relative age score of 0.26. The low relative age score of the plants recorded at site N_T1 indicates recent establishment of *Calotropis* plants at this location. It is likely that seed dispersal from the *Calotropis* infestation site T7, located 400 m south, is responsible for the establishment of *Calotropis* plants at site N_T1. Effective control of newly established *Calotropis* occurrence locations is critical to reducing the spread of *Calotropis* across the landscape.

The most populous *Calotropis* occurrence location within the WAPR, site T7, was controlled again in 2023. The number of *Calotropis* plants recorded at site T7 decreased significantly following initial control works undertaken in 2021, from ~1550 plants recorded in 2021 to 806 plants in 2022. Following this initial control event, the number of *Calotropis* plants at site T7 has not significantly reduced, with 824 *Calotropis* plants recorded at site T7 in 2023. Mature *Calotropis* plants at site T7 were observed to have a high propensity for resprouting following control in both 2022 and 2023, and plants which had regrown following control were recorded as mature in 2023. It was noted in the field that plants which had regrown from cut stumps appeared to be less vigorous than observed in 2022.

The relative age score of the *Calotropis* infestation at site T7 was 0.36, indicating the stand was comprised mainly of juvenile plants. As such, the small increase in the number of *Calotropis* plants at site T7 can likely be attributed to large-scale recruitment following control works implemented in 2022. Observationally, the average age of the *Calotropis* plants at site T7 appears to be decreasing each year.

Control works implemented over the last three years, have likely prevented a significant increase in *Calotropis* density at site T7. The *Calotropis* density at site T7 was ~59 plants/ha in 2022, and ~61 plants/ha in 2023. As exponential increases in *Calotropis* density can be observed in medium density stands (~250-550 plants/ha), ensuring stands do not reach density levels which are conducive to maximum fecundity is also vital to reducing the spread of *Calotropis* (Campbell et al., 2015). Control works should continue to be undertaken annually at site T7 as a priority, to ensure that the *Calotropis* stand density remains within the acceptable density range.

The resistance to control treatment of *Calotropis* plants observed at site T7 in 2022 and 2023 indicates that alternative control methods should be investigated and, if feasible, implemented. Resprouting of *Calotropis* plants following control has been observed very infrequently throughout the rest of the WAPR, and the 'cut and paint' control method has, to date, been successful in treating all other *Calotropis* stands.

Targeted *Calotropis* surveys were undertaken in the Turner River on Trip 1 and 2 however, in the absence of written permission from Karriyarra Aboriginal Corporation (KAC), a decision was made by Senior Rangers to avoid conducting works within the Karriyarra Native Title Determination Area of the WAPR on subsequent trips. As a result, three *Calotropis* occurrence locations (T5, T6 and TT1) recorded in 2022 were not resurveyed this year.

Targeted *Calotropis* surveys and control works should continue to be undertaken within the Turner River in 2024, particularly in light of the restricted survey area in 2023 and the high propensity for regrowth following control observed at site T7. Follow-up control of emergent growth at occurrence locations controlled in 2023 should be undertaken as a priority. Additionally, it is recommended that targeted *Calotropis* surveys continue to be undertaken within the Turner River to identify and treat *Calotropis* outbreaks in new areas. Ensuring all *Calotropis* stands remain within the acceptable density range is vital to controlling the spread of *Calotropis* within the WAPR. Ongoing surveillance and control works, within the Turner River, are vital to slowing the spread of *Calotropis* across the landscape.

Access to riparian zones

Restricted vehicle access within riparian zones was a major obstacle encountered during the 2022 works. Increased access to riparian zones, particularly within the southern portion of the WAPR, was achieved during the 2023 works. This increased access was facilitated primarily by two factors: emphasis on attendance of Senior Knowledge Holders and Cultural Authorities on all On-Country trips and the use of off-road buggies.

Attendance of Cultural Authorities and Senior Knowledge Holders on all trips enabled the team to safely undertake *Calotropis* survey works within a greater portion of the Woodstock Reserve, particularly within the Yule River system. Senior Knowledge Holders and Cultural Authorities provided guidance on avoidance areas and existing access routes, ensuring the cultural safety of trip participants, and thereby expanding the survey area. Avoidance areas within the reserve were mapped and directions provided by Cultural Advisors were followed stringently.

Sections of the Coorong Creek and Coonarie Creek were identified as avoidance areas by Senior Rangers. The survey route was modified based on updated avoidance area information supplied by Cultural Authorities, hence some areas previously surveyed in 2022 were not resurveyed in 2023. No *Calotropis* plants have been recorded in previous years within the sections of the Coorong Creek which have been flagged as avoidance areas. The boundaries of these avoidance areas will be managed for *Calotropis* under direction of the relevant Cultural Authorities in 2024 and beyond.

The use of two off-road buggies was contributed in-kind to the project by Senior Rangers Kevin Stream Snr. and Walter Stream during Trip 3. These buggies, operated by the Senior Rangers, played a crucial role in targeted *Calotropis* surveys within riparian zones of WAPR, granting access to previously inaccessible areas, including stretches of the main body of the Yule River. The off-road buggies' capabilities enabled more thorough surveying of riparian areas, overcoming the limitations of light vehicle access in dense vegetation. Their use during Trip 3 resulted in the identification of 96 *Calotropis* plants at six discrete locations within the Yule River, discoveries that may not have been possible without this specialised equipment.

During 2023, a decision was made by Senior Rangers to cease works within the Karriyarra Native Title Portion of the WAPR (Abydos). Without written permission from Karriyarra Aboriginal Corporation (KAC), it would be irresponsible for Budadee Aboriginal Corporation to undertake *Calotropis* management works within Abydos. Continued dialogue with KAC will assess management of this area, and pathways for a KAC lead weed control program will be explored if it is the opinion of KAC that Palyku organisations should continue to avoid conducting works within Abydos.

Long-term Management

Since the commencement of the Woodstock Environmental Offset Project in 2021, approximately 5,200 *Calotropis* plants have been controlled within the Woodstock Abydos Protected Reserve. The number of *Calotropis* plants recorded each year within the WAPR has continued to decline throughout the project from ~2711 *Calotropis* plants in 2021, 1424 plants in 2022, and 1137 plants in 2023. Reductions in the number of *Calotropis* plants within the WAPR have been recorded despite increases in the total riparian survey effort in 2023, indicating these reductions are accurate reflections of control success as opposed to the result of reduced survey effort.

Distribution and density of *Calotropis procera* across the reserve suggests recent establishment. There is some variation within the literature regarding the density rates considered low density with Campbell et al. (2015) identifying low density *Calotropis* stands as having <250 plants/ha; and Menge et al. (2016) referring to low density *Calotropis* stands as having <350 plants/ha. Even the most dense *Calotropis* infestations recorded within WAPR in 2023, site T7 (~61 plants/ha) is considered well within the low density classification range presented in the literature (Campbell et al. 2015, Menge et al. 2016).

The *Calotropis* control works undertaken over the last three years have successfully reduced *Calotropis* numbers within the Yule River system to a level which can feasibly be managed through Budadee's DBCA Ranger Program. The Budadee Ranger team will continue to undertake targeted *Calotropis* surveys and follow-up control works within the Yule River system, as per best practice methods for *Calotropis* control programs. Follow-up control will be undertaken ~12 monthly at priority sites to prevent replenishment of soil seed banks. Priority sites to be resurveyed in 2024 include sites N_Y1, N_Y7, N_Y8 and N_Y9 within the Yule River (main) and site N_C1 within the Coorong Creek. Additionally, targeted *Calotropis* surveys will continue to be undertaken annually within the Yule River system to identify and control any new *Calotropis* occurrences.

Field data will continue to be collected during *Calotropis* survey and control works as per established methodology, to ensure the success of control works can continue to be evaluated and adaptations to control methodology can be explored if needed. Comparison of relative age scores following control events will become a particularly useful measure in terms of tracking the success of control works. Furthermore, it is recommended that *Calotropis* survey and control works be expanded outside of the WAPR in the future to create a buffer to reduce the risk of dispersal from outside of the reserve boundary.

The targeted *Calotropis* control works undertaken within the WAPR to date, paired with ongoing surveillance for *Calotropis* and ~12-monthly follow-up control at priority sites, will likely be effective at preventing dense, large-scale infestations of *Calotropis*

within the WAPR such as those seen in the De-Grey River, Brockman River, and parts of the Turner River outside the WAPR. Expansion of *Calotropis* control and survey works outside of the WAPR in the future is recommended to create a buffer to reduce the risk of dispersal from outside the reserve boundary. Avenues for expansion of the control program down-river in collaboration with regional stakeholders will continue to be explored (Traditional Owners, pastoralists, mining, public sectors etc.).

The final on-country trip of Stage 2 is currently scheduled for March 2024. This on-country trip will prioritise undertaking *Calotropis* survey and control works and capturing vegetation management priorities of the Budadee Ranger team including Senior Rangers, Cultural Advisors and Elders. Management priorities which have previously been flagged by the Budadee Ranger team include control of other weed species of concern within WAPR, such as Mimosa Bush and Mexican Poppy, and management of *Calotropis procera* within the rivers around Nullagine. The riparian management priorities of the Budadee Ranger team will guide future management direction, and the Budadee Ranger Program will continue to protect the rich environmental and cultural values within the WAPR through management of these threats.

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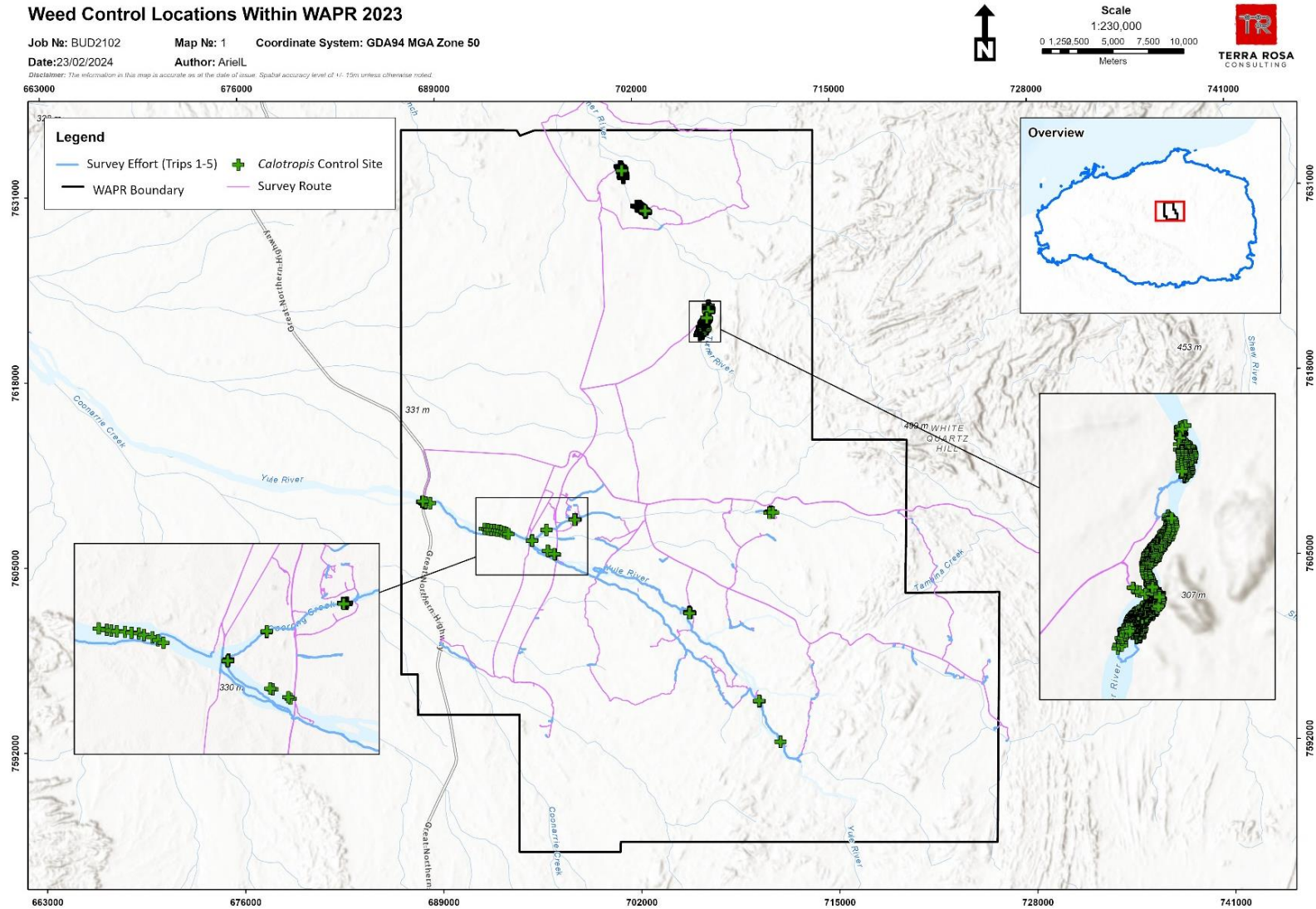
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Appendix 1: Maps

Map 1: *Calotropis procera* (juvenile and mature individuals) Distribution in 2023



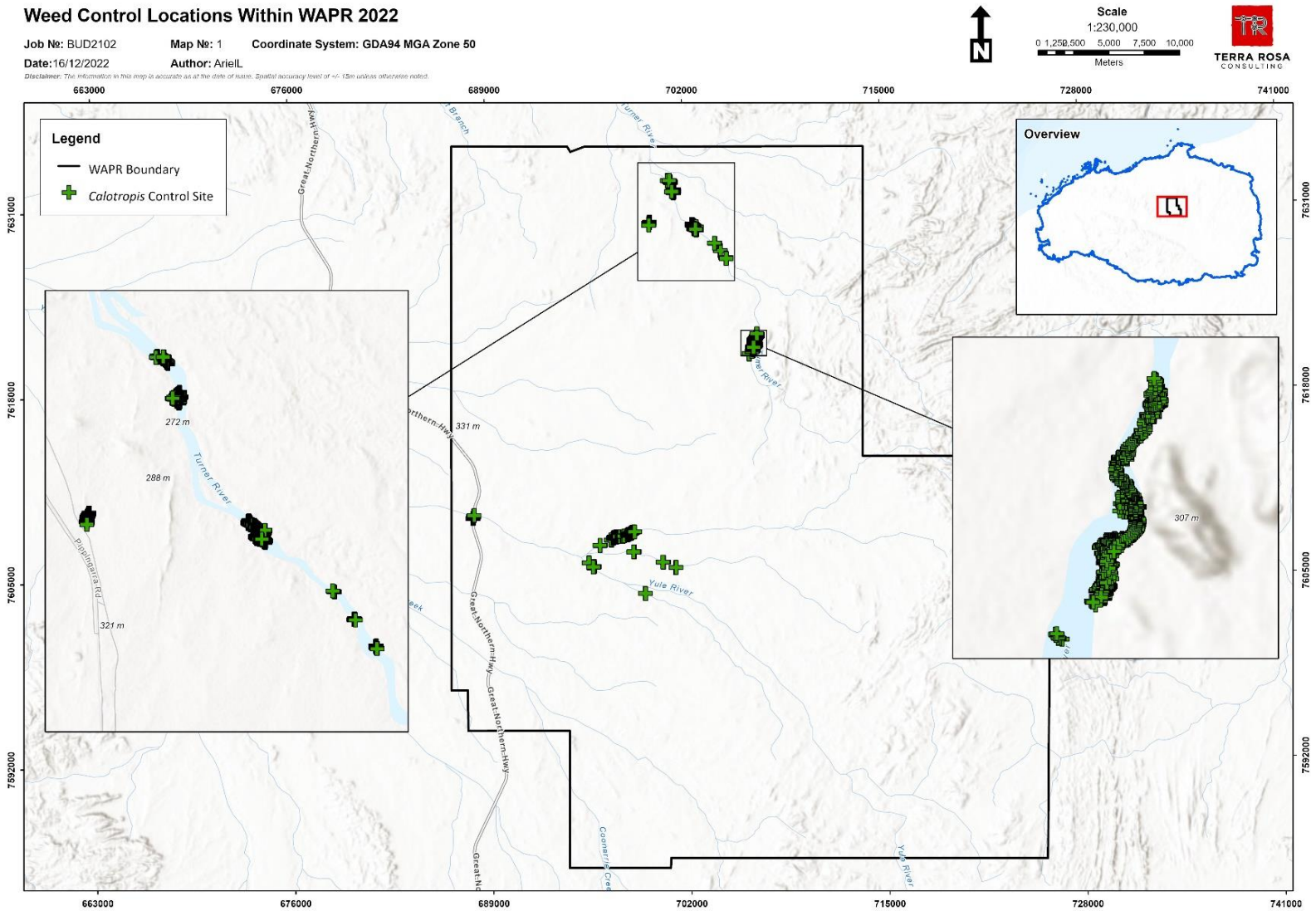
Map 2: *Calotropis procera* (juvenile and mature individuals) Distribution in 2022

Weed Control Locations Within WAPR 2022

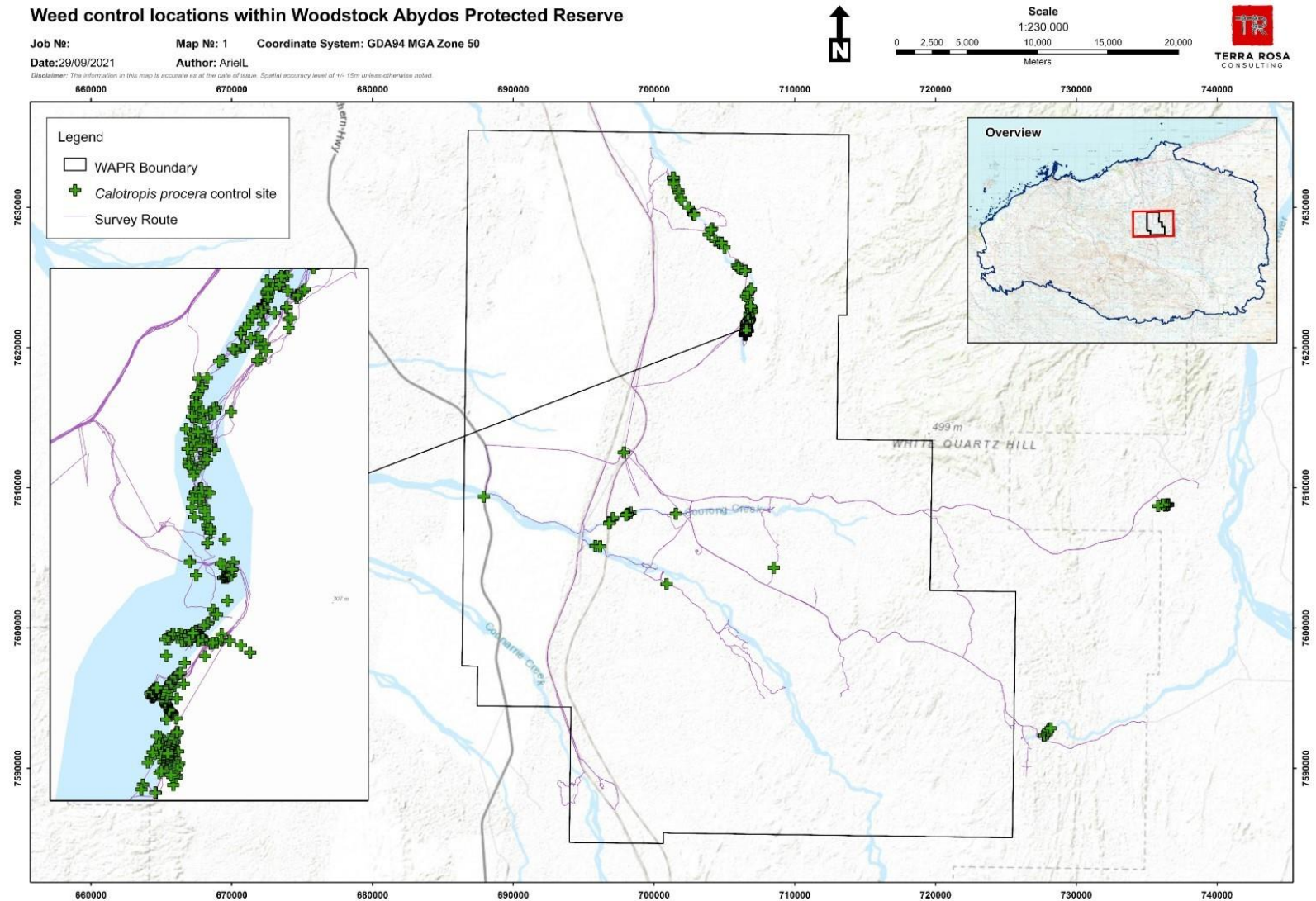
Job No: BUD2102 Map No: 1 Coordinate System: GDA94 MGA Zone 50

Date: 16/12/2022 Author: Ariel L

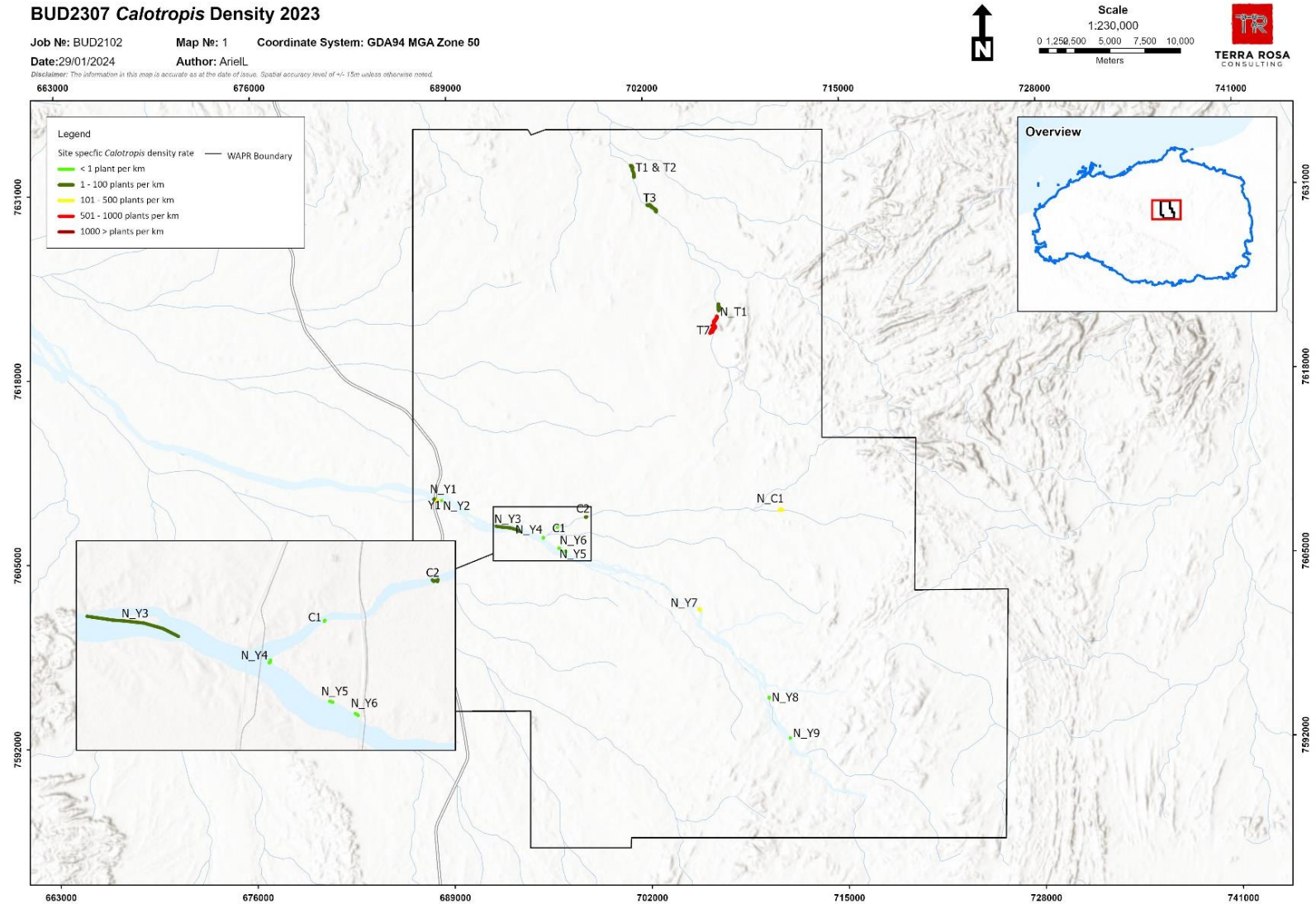
Disclaimer: The information in this map is accurate as at the date of issue. Spatial accuracy level of +/- 15m unless otherwise noted.



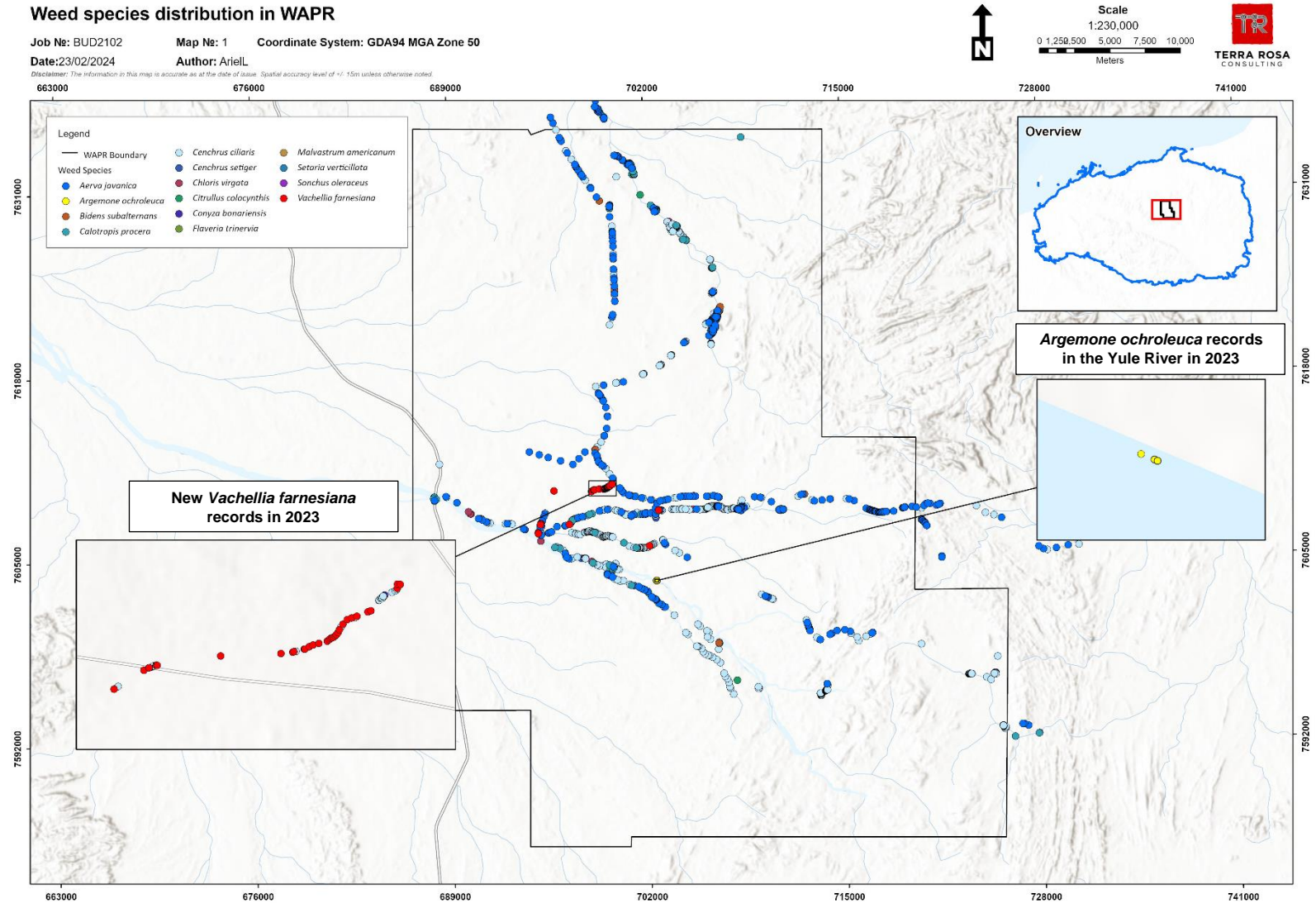
Map 3: *Calotropis procera* (mature individuals) Control Locations in 2021



Map 4: Discrete occurrence locations of *Calotropis procera* recorded within WAPR in 2023. Colours represent relative density class of each discrete location; codes assigned to discrete locations displayed as labels.



Map 5: Non-target Weed Species Distribution in WAPR (2021-2023).



Appendix 2: Project Contacts

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Quality Statement

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