Incineration as a control method to manage Tiger Pear (*Opuntia aurantiaca*)

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Key Points

- A Weed of National Significance - Tiger Pear (Opuntia aurantiaca) is threatening the environmental values along Little River, Victoria
- Existing control program is containing infestation levels rather than achieving eradication
- Control program requires multiple management techniques to achieve year round treatment
- Incineration of Tiger Pear by propane torch was trialed as an alternative method in addition to herbicide application
- Incineration can provide benefits as a winter control method for Tiger Pear in conjunction with herbicide treatment

Abstract

Tiger Pear (*Opuntia aurantiaca*) is an aggressive drought tolerant perennial sterile hybrid. A species of opuntioid cacti, it is a weed of national significance. The largest infestation within Victoria occurs within Melbourne's Western Plains District along the Little River. Melbourne Water has been managing this infestation since 2008 and it has been resource intensive, costly and slow to achieve outcomes. Incineration by a propane fuelled flame torch was trialed as an alternative management technique to herbicide application. The trials took place on 3 separate sites on infestations with varying ground cover. Treatment using a propane fuelled flame torch was not effective as a sole control method. The use of a propane torch on low density or sporadic infestations masked by ground cover is a viable winter treatment. Follow up treatment with herbicide is essential to achieve an effective kill rate.

Keywords

Tiger Pear, Cactus, Optunia, Incineration, Victoria, Little River

Introduction

Tiger Pear (*Opuntia aurantiaca*) is a species of opuntioid cacti and is considered a weed of national significance. A cactus native to South America, it was first noted in New South Wales in the late 1800's. By 1911 it was recognised as a serious threat in New South Wales. Within Victoria the plant is recorded in five locations (Dance, Adams & Simmons 2003). The largest of these infestation locations occurs along Little River in Melbourne's Western Plains district.

Consistent with other types of opuntioids, the Tiger Pear grows as a dense, low growing shrub (<50cm). Opuntioids are distinguished from other families of Cactaceae by the presence of glochids (small, detachable barbed bristles). The plant is segmented into partly flat to round cladodes (stem segments) which can readily detach when disturbed or under stress. Tiger Pear survives and thrives via vegetative reproduction rather than seeding. It typically grows on river banks, pastoral areas and rocky crevices. Although the plant does not establish in wet riparian zones, its dispersal is mainly attributed to fluvial processes and to a lesser extent by animals and humans. Once segments detach they readily establish wherever they lodge and quickly form impenetrable groundcover thickets.

1. Melbourne Water commenced controlling Tiger Pear at Little River in 2008. The treatment methods to date have primarily been via herbicide application (3% Triclopyr (Garlon 600)) with manual removal also occurring on small infestations. Despite a targeted program over 5 years at a cost of approximately $1.2M, Tiger Pear is still present along Little River. Opportunities to treat Tiger Pear are typically restricted to 3-4 months

(Spring/Autumn) due to the following constraints: Tiger Pear adopts Crassulacean Acid Metabolism (CAM) process, meaning the stomata is only opened at night as a method of water conservation. The combination of closed stomata and a waxy outer coat limits herbicide absorption during the day,
2. Use of residual herbicides or petroleum based products along waterways is restricted by Melbourne Water,
3. Preferred herbicide Triclopyr in ester and salt formulation is degraded readily in sunlight and studies have shown that midsummer photodegradation can start to occur after 2 hours (McCall & Gavit 1986),
4. During winter Tiger Pear is dormant, reducing stomata opening and the ability to uptake herbicide,
5. Triclopyr starts to volatilize once temperatures exceed 27oC leading to off target damage,
6. Untreated segments remain viable for asexual reproduction,
7. This site is prone to grassfires, with 3 severe fires in the last 3 years. Access is restricted during Total Fire Ban days or when conditions present a high fire risk (e.g. high temperatures and strong winds),
8. In the period November 2013 to March 2014 there were only 30 days out of a possible 107 operational days suitable for treating Tiger Pear at Little River. Wind conditions and temperature dictated suitability, and
9. There are several locations along Little River where Growling Grass Frog (Litoria Raniformis) (listed as Vulnerable under the EPBC Act) is known to exist. This restricts the use of Triclopyr at these sites.

An inspection of a Tiger Pear control program along a 7km reach of Little River in May 2013 highlighted the limitations of completely relying on herbicide for control. Despite treatment with 3% Triclopyr in March-April 2013, numerous green healthy segments were evident especially where visibility was masked by grasses. Based on anecdotal evidence that a recent hot grass fire had severely impacted a Tiger Pear infestation, trials were undertaken to investigate the effectiveness of a propane fuelled flame torch. If Tiger Pear can be eradicated on its initial treatment, the knock-on effects are lower maintenance costs and an overall reduction in capital investment. Incineration on a small or large scale (prescribed burn) would also provide an option for treating weeds in cooler months.

Methodology & Results

Three separate trials investigated incineration of Tiger Pear (location map in the Appendix). Trials were carried out using two personnel; one carrying the flame torch and the other carrying a knapsack filled with water. Trial sites were sprayed with water and monitored for 30 minutes after treatment to ensure fires did not ignite. Figure 1 in the Appendix shows a map of the three trial sites.

Equipment

Various flame torches were investigated and a propane torch branded as a "Weed Dragon ®" Vapour Torch VT2-23 by Flame Engineering, INC was sourced from Gameco in Melbourne. Temperatures of approximately 2,050 °F can be reached when using the torch at maximum capacity. The propane torch comprises of an 86cm hand held torch attached by a 3m length hose to a propane tank. The flow of gas is controlled by squeeze valve with adjustable pilot on the handle of the torch. The flame torch can be fitted to a 9kg or 4kg propane tank, working more efficiently with a 9kg tank. However, a 4kg tank was used as it is lighter to carry around site. In accordance with Australian Health and Safety Standards, the gas tank cannot be carried on a persons' back. Specifications for a "Weed Dragon ®" Vapour Torch VT2-23 can be found at https://www.flameengineering.com/product-detail.php?product_id=15.

Trial No. 1 – Incineration following herbicide treatment

Trial No. 1 was carried out on a section of Little River that formed part of the 2011/2013 Melbourne Water capital project (DI 1898). The trial site was located on the east bank of Little River (on private property) immediately upstream of Mouyong Reserve. Trial No. 1 would address the following unknowns:

1. Can Tiger Pear be killed by heat treatment?
2. If heat treatment is applied to the main stem will it kill the entire plant?
3. Is heat treatment cost effective? Cost effectives would be related to the time duration required to adequately treat Tiger Pear which in turn is related to the size and maturity of the plant,
4. Is a combined method required e.g. herbicide plus heat treatment? If so then which method should be used as initial and follow up?
5. Is visibility of the plant improved so all segments can be targeted and treated?
6. Safety risks associated with using propane fuelled flame torch and ease of use?

7. Rate at which gas is utilised and size of gas tank required? and
8. If effective, can the apparatus be modified to operate similar to a quick spray unit?

Heat treatment was carried out on six tiger pear plants of varying size and maturity in June 2013. All plants were located within a 10m buffer zone and had been treated with herbicide at a rate of 3% Triclopyr approximately six weeks previously. After initial treatment, the site was inspected on three occasions to monitor the quality/degradation/form of the plant. The observations from each inspection are detailed in Table 1.

Table 1. Trial No. 1: Description of Test Plants, Treatment and Observations

Site	Description *(Previously sprayed with 3% Triclopr)*	Treatment	Observations		
		17 June 2013	2 July 2013 (2 Weeks After Treatment (WAT)	21 August 2013 (9 WAT)	31 December 2013 (28 WAT)
1	One main stem with two branches. Outer segments were yellow & black. Main stem at root was green.	Yellow flame - 20 secs Treated green portion. Tiger Pear expanded & drooped. Spines incinerated	No noticeable change. Bristle grew back. Outer segments green, firm and viable	No noticeable change. Plant appears healthy, firm to the touch. Nodal point between segments is yellow/brown colour	Segments are black and shriveled. Segments brown and rotten on the inside.
2	Thick main stem with multiple segments. Main stem brown at the base. Interior segments are thick and green. Outer segments black & shriveled.	Blue flame - 3 minutes Treated the thick green segments for 3 minutes until black and charred	Plant yellowed and shriveled. Main stem firm to the touch. Outer segments withered & soft to the touch. Spines have not grown back.	Main stem white/grey colour. Main stem withered. Outer segments withered &soft to the touch. Spines have not grown back.	Plant has disintegrated, only a small section of main stem remains. Segments soft & brown on inside.
3	Multi stemmed plant. Outer segments red & black. Segments close to the base are green	Blue flame - 1 min 22 seconds 2 green segments at the centre branch were completely charred. Remainder of the plant subjected to indirect heat. Discolored and swelled slightly.	Plant collapsed. No longer erect. 2 green segments have withered and died. Main stem brown and firm. Other segments have withered. Outermost segments detached from main plant to lie on the ground.	Centre of plant decomposed, segments have withered. Adjoining segments have collapsed and withered. Brown mushy flesh. Main stem is whitish colour and shriveled.	All segments black & withered. Main stem white/grey, withered & soft. Still slightly green on inside. . Root system excavated - root bulb & 1.5m long tap root. Root bulb moist white interior.
4	Small plant only 2 segments (no signs of herbicide uptake)	Yellow flame – 24 seconds Spines incinerated. No discoloration or swelling.	Spines have started to regrow. Plant seems unaffected.	Plant no longer at location.	Plant no longer at location.
5	Small plant, with 3 to 4 small segments in each branch (no signs of herbicide uptake)	Blue flame – 15 seconds 2 segments were incinerated until charred and steaming.	2 segments (charred and black) have withered and died. Other segments have yellowed - green on the inside.	Plant has completely shriveled and decayed.	Plant could not be located.

Site	Description *(Previously sprayed with 3% Triclopr)*	Treatment	Observations		
		17 June 2013	**2 July 2013 (2 Weeks After Treatment (WAT)**	**21 August 2013 (9 WAT)**	**31 December 2013 (28 WAT)**
6	Plant has large main stem with multiple large branches & multiple segments. Fruit present. Outer segments red, black and shriveled. Only half the plant incinerated.	Blue flame – 7 minutes. Flame torch at full capacity. Treated segments went through following transition: Green to pale green to yellow and then begin to sweat, water droplets seeped from the segments, then changes from light brown to dark brown to black & crispy. Treated segments withered and soft to touch.	Treated section has died off significantly in comparison with untreated half (herbicide treatment only). Treated section has yellowed and the majority of segments have withered and died. Large segments very soft to touch and are decomposing on the inside. Segments which lay underneath other segments appear green and viable.	Treated section appears shriveled, black and grey. Green and viable nodes apparent in other half of the plant (herbicide treatment only). Segments which were lying under other segments & previously appeared viable are now shriveled and black.	Both sections (incineration & herbicide treatment only) appear withered and black. Root system excavated - Root bulb & 1.9m long rap root. Tap root is thin, woody & fibrous. Tap root grew around rocks changing direction when it met a rock. Tap root became thinner towards its end & less woody/fibrous in texture.

Tiger Pear was treated to varying degrees of success depending on the heat treatment applied. However as Tiger Pear was previously treated with herbicide a second trial was carried out to verify if Tiger Pear can be killed by incineration alone.

Trial No. 2 – Incineration as the sole treatment method on a high density infestation

Trial No. 2 was carried out on a section of Little River that formed part of the 2013/2017 Melbourne Water capital project (DI 2068). The aim of Trial No. 2 was to treat Tiger Pear which occurred in a dense infestation and had not previously received herbicide treatment. The intensity of burning treatment was guided by findings from Trial 1.

The trial site was located on private property along the east bank of Little River, approximately 250m downstream of Mouyong Reserve. This section of waterway has steep incised banks with rocky outcrops and dense vegetation consisting of native and non-natives species. Non native species consist primarily of African Boxthorn and Tufted Honey Flower. No substorey vegetation was present which allowed for easy access. The trial site measured 5m by 10m and was covered by a carpet infestation of Tiger Pear. The trial site was divided into three plots and each plot was demarcated by white and yellow painted 750mm hardwood stakes.

Initial treatment was carried out on Trial Site No. 2 on the 8th November 2013. After initial treatment, the site was inspected on the 31st December 2013. The observations from each inspection are detailed in Table 2.

Table 2. Trial No. 2: Description of Test Plants; Initial Treatment and Observations

Trial No. 2	Description	Treatment Type	Observations (8 WAT)
Plot 1	Plot No. 1: 4m x 0.5m. Dense "carpet" infestation of Tiger Pear of varying sizes.	Blue Flame – Segments treated until charred & black All Tiger Pear segments burned until charred and black. Heat Treatment took 50 minutes for Plot No. 1. During incineration Tiger Pear segments which were upright & erect, visibly deflated.	Treated Tiger Pear segments have withered and appear yellow on the inside. New emergent segments are evident and appear to be shooting up from the bulb. These segments are green and erect.
Plot 2	Plot No. 2: 4m x 0.5m. Dense "carpet" infestation of Tiger Pear of varying sizes.	Blue Flame – Segments treated until discoloured to a brown colour or until water droplets appeared on the surface. Heat treatment took 4 minutes for Plot no. 2	New segments and fruit sprouting from the tips of the tiger pear segments which were treated. The treated segments and the new emergent segments are viable. Segments are green and firm on the inside.
Plot 3	Plot No. 3: 0.5m x 0.5m Dense "carpet" infestation of Tiger Pear of varying sizes.	Blue flame – Segments treated until discolored to a light brown colour and spines disintegrated. Heat treatment took 2.5 minutes for Plot no. 3.	Outer skin of treated Tiger Pear segments appears blotchy, white & brown in colour and slightly wrinkled. New segments and fruit sprouting from the tips of the treated tiger pear segments. Both treated segments and the new emergent segments are green and firm on the inside.

Treating Tiger Pear in high density infestations is quite time consuming. A third trial was carried out to investigate incineration as a treatment method in a low density infestation.

Trial No. 3 – Incineration as the sole treatment method on a low density infestation

Trial No. 3 was carried out on a section of Little River that formed part of the 2013/2017 Melbourne Water capital project (DI 2068). The aim of Trial No. 3 was to investigate the effectiveness of heat treatment on low density infestation of Tiger Pear.

The trial site was located on the Wyndham Council Reserve (McNaughton Reserve) on a rocky outcrop. The Council Reserve has received treatment for Tiger Pear in the past by the Council and the infestation is sporadic. This section of the reserve is covered with groundcover vegetation making identification of Tiger Pear difficult. The trial site consisted of a 200 square meter area within the reserve. Two personnel walked the trial site with the flame torch and a knapsack filled with water.

Trial No. 3 was carried out on the 8th November 2013. After initial treatment, the site was inspected on the 31st December 2013. The observations for Trial No. 3 are detailed in Table 3.

Table 3. Trial No. 3: Description of Test Plant Initial Treatment and Observation

Trial No. 3	Description	Treatment Type 08.11.13	Observations 31.12.13
Trial No. 3	Trial Site: 200 m^2 Sporadic occurrences of Tiger Pear consisting of juvenile to medium sized plants.	Blue Flame –Segments treated until charred & black. Flame torch on low, no trigger. Two crew walked through the trial site locating Tiger Pear plants. All Tiger Pear segments were burned until charred and black. Heat Treatment took between 30seconds to 4 minutes depending on the size of the plant. It took approximately an hour to cover a 200m^2 area.	All Tiger Pear segments have withered and appear yellow on the inside. Root system was exposed on two plants to reveal a bulb and tap root system. Root bulbs are firm and appear to be unaffected by treatment.

Discussion

Lessons from Trial 1

The trigger on the flame torch enables you to have gas at lower volume but with the same high blue flame output. There is quite a lot of smoke when burning large Tiger Pear plants therefore it is necessary to wear a respirator. When the flame torch is not in use, the gas must be turned off at the tank and excess gas must be released from the hose. It is safer to use a two person team when carrying out this treatment method. The person with the water knapsack can control the gas release from the tank and the operator can concentrate on treating the Tiger Pear. Australian safety regulations prevent a fuel source from being carried as a backpack on a person.

In order to achieve a successful kill each segment must be burned using the blue flame until the skin turns black and moisture is released. Plants which were treated with the yellow flame and burned only until the spines disintegrated did not achieve a successful kill rate. During the July 2013 inspection, it was noted at Site 6 that segments had survived where they lay under other segments. Therefore to ensure a successful kill rate, all segments must be targeted and treated. This however is quite time consuming as large plants have a multitude of segments. As the trial plants were previously treated with herbicide it is difficult to determine whether the degradation is due to chemical or heat treatment.

This treatment method should be only be utilized outside the fire restriction period. The surrounding grass vegetation around Tiger Pear caught fire easily however due to the time of year, vegetation was quite wet and fire did not spread. An advantage of using this treatment method is the ability to see the full extent of the plant as the surrounding vegetation (usually grass) is also incinerated. Thus the risk of missing segments is reduced when compared to herbicide treatment.

During an inspection in December 2013 (28 weeks after treatment (WAT)) the root system of the treated Tiger Pear plants was excavated. For juvenile plants a long thin tap root was uncovered. For large mature plants, a bulb and tap root system (over 2m in length) was uncovered. The segments on the surface appeared dead however in the case of the largest plant (Site 6) the bulb and tap root system appeared to be unaffected by treatment. These findings suggest that incineration of segments on the ground does not affect the root system therefore incineration cannot be relied on to completely eradicate Tiger Pear. As regrowth can occur from a viable root system, complete eradication of any Tiger Pear plant cannot be achieved unless the root system is also treated. The findings from Trial No. 1 suggest that a combination of incineration and herbicide treatment is required to eradicate Tiger Pear; incineration reveals the complete extent of a plant so all segments are treated and herbicide treatment can target the root system. However it should be noted that further studies would be required to confirm if herbicide treatment is able to reach and kill the root system.

Lessons from Trial 2

A similar observation from Trial 1 was validated in Trial 2. In order to achieve a successful kill rate the segments must be treated with a blue flame until the skin is black and moisture seeps from the plant. Treating a 4m by 0.5m area of dense infestation took 50 minutes. When the trial site was revisited, it was noted that the plants which were treated with blue flame until black and charred were dead. However new segments were emerging from the base of the treated plants. These segments were bright green and erect. Segments which had been lightly treated with a blue flame until a yellow/brown colour were not dead. New segments were sprouting from the tips of treated segments. Propane gas usage was approximately at a rate of 1.2L per 1 hour with the flame on full (local conditions 15°C and overcast)

When treated with a blue flame until black and charred, Tiger Pear segments are effectively killed however the root system does not appear to be affected. New segments were able to emerge from the root system. Incineration is a sole treatment method is not effective at eradicating Tiger Pear unless used in conjunction with herbicide treatment.

Lessons from Trial 3

During the trial in November it was difficult to visibly locate Tiger Pear amongst vegetation consisting of groundcovers (predominantly Galenia). Treatment may be easier in Autumn after grasses have browned off and fire restrictions have lifted. A large amount of smoke was created when the vegetation surrounding a Tiger Pear plant was incinerated. On the day of the trial, winds were approximately 20kmh thus increasing the appearance of smoke. Local wind conditions of less than 10km would be more suitable. Incineration removes surrounding vegetation and leaves a visible charred area. This allows for easy identification of previously treated plants in follow up visits. A common issue with herbicide treatment is dye used during spraying fades over time. This makes it difficult to relocate treated plants for follow up treatment.

Trial 3 further confirmed two observations from the previous trials; In order to kill a segment they must be treated with a blue flame until the skin is black and moisture seeps from the plant and eradication of the plant cannot be achieved unless the root system is also treated. Incineration has removed the risk of transport by animals as the spines have been removed. In addition, if the plants are transported by flood waters then regrowth will not occur as the segments are dead. Treated Tiger Pear plants within the trial site appeared dead 6 weeks after treatment however the root systems appeared unaffected and healthy. It is likely re-growth from viable underground root system will occur and follow-up treatment will be required to achieve effective control.

Conclusions

Incineration of Tiger Pear using a propane fuelled torch is not effective as a sole method of control. Herbicide treatment following incineration would be more effective as the burned plants are easier to see, surrounding vegetation is removed exposing all segments, spines have been destroyed reducing safety risks and the waxy outer coat has been destroyed which may improve herbicide uptake. All segments must be burned with blue flame until the skin is charred black and moisture has seeped from the surface.

Incineration is recommended as an initial treatment method to expose the full extent of the plant. Follow up treatment with herbicide is required as Tiger Pear is able to sprout new segments from its base after incineration of the segments. Incinerating dense carpet like infestation is time consuming and not financially viable. Herbicide treatment is a more efficient method of control for dense infestation. Treatment by incineration is comparative financially to herbicide treatment when used in low density infestations. The charred spot can be easily spotted which will also make follow up treatment with herbicide more efficient. Incineration is useful when Tiger Pear is present within and/or under indigenous vegetation where the risk of herbicide off target damage can occur. Incineration is also a suitable alternative to herbicide treatment for treating infestations in sensitive areas with endangered fauna e.g. Growling Grass Frogs at Little River. Further observations will be required to verify if Tiger Pear can sprout from the bulb or tap root system after the head of the plant has been treated with herbicide.

This paper discusses a small component of Tiger Pear treatment. Numerous agencies are involved in treating Tiger Pear along Little River including Melbourne Water, City of Greater Geelong Council, Wyndham Council and VicRoads. These bodies restarted a Tiger Pear Task Force in 2013 to facilitate integrated management of Tiger Pear. The lessons learned from this research and the Task Force has highlighted that detailed mapping of the infestation is required to accurately assess the effectiveness of previous control programs. This can then be used to predict what will be required to achieve a satisfactory control level. Other methods are being trialed by these bodies including cochineal release, alternative herbicides and mechanical control methods. The use of a propane fueled flame torch provides another tool for an integrated control program.

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Appendix

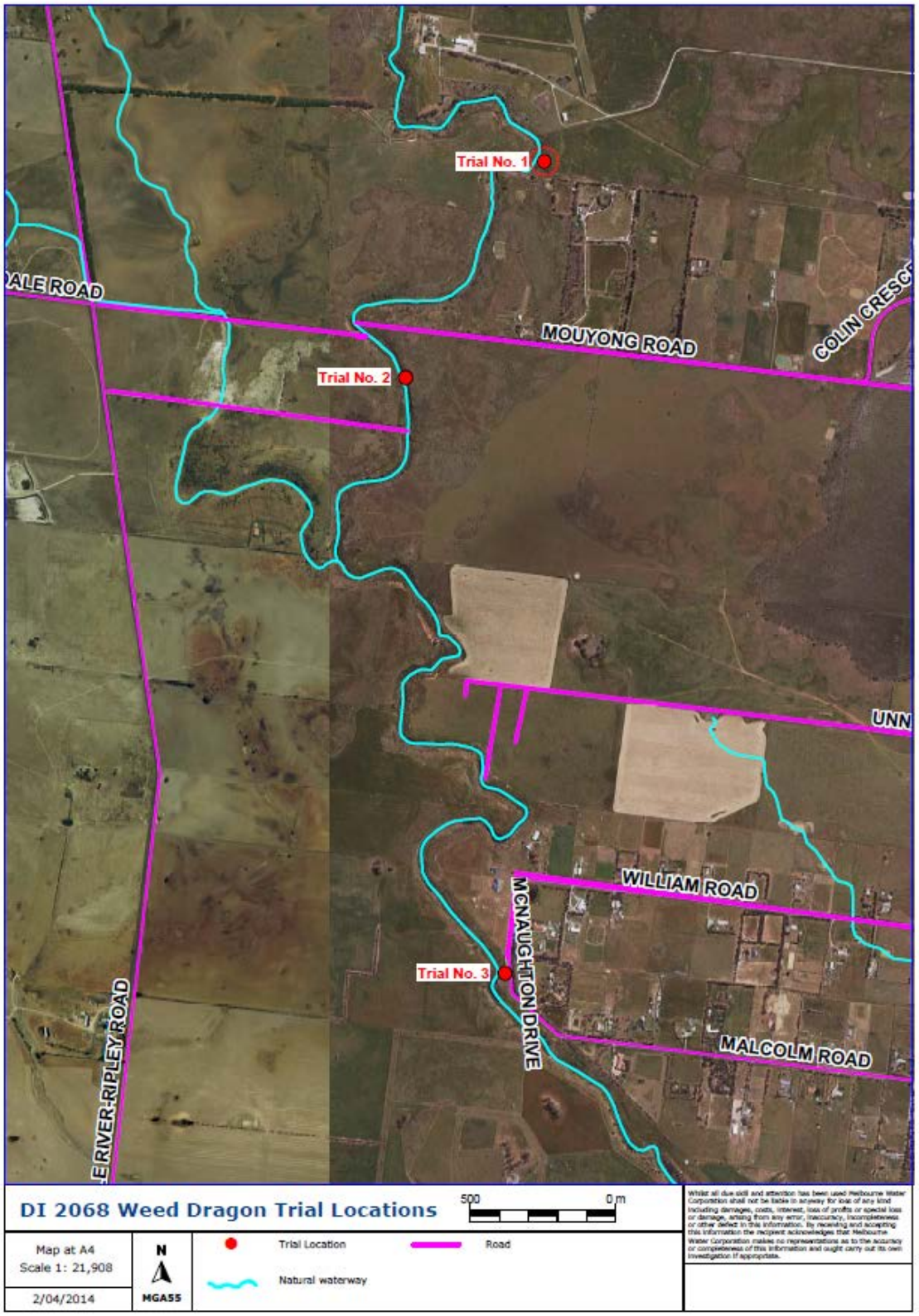

Figure 1. Trial Sites