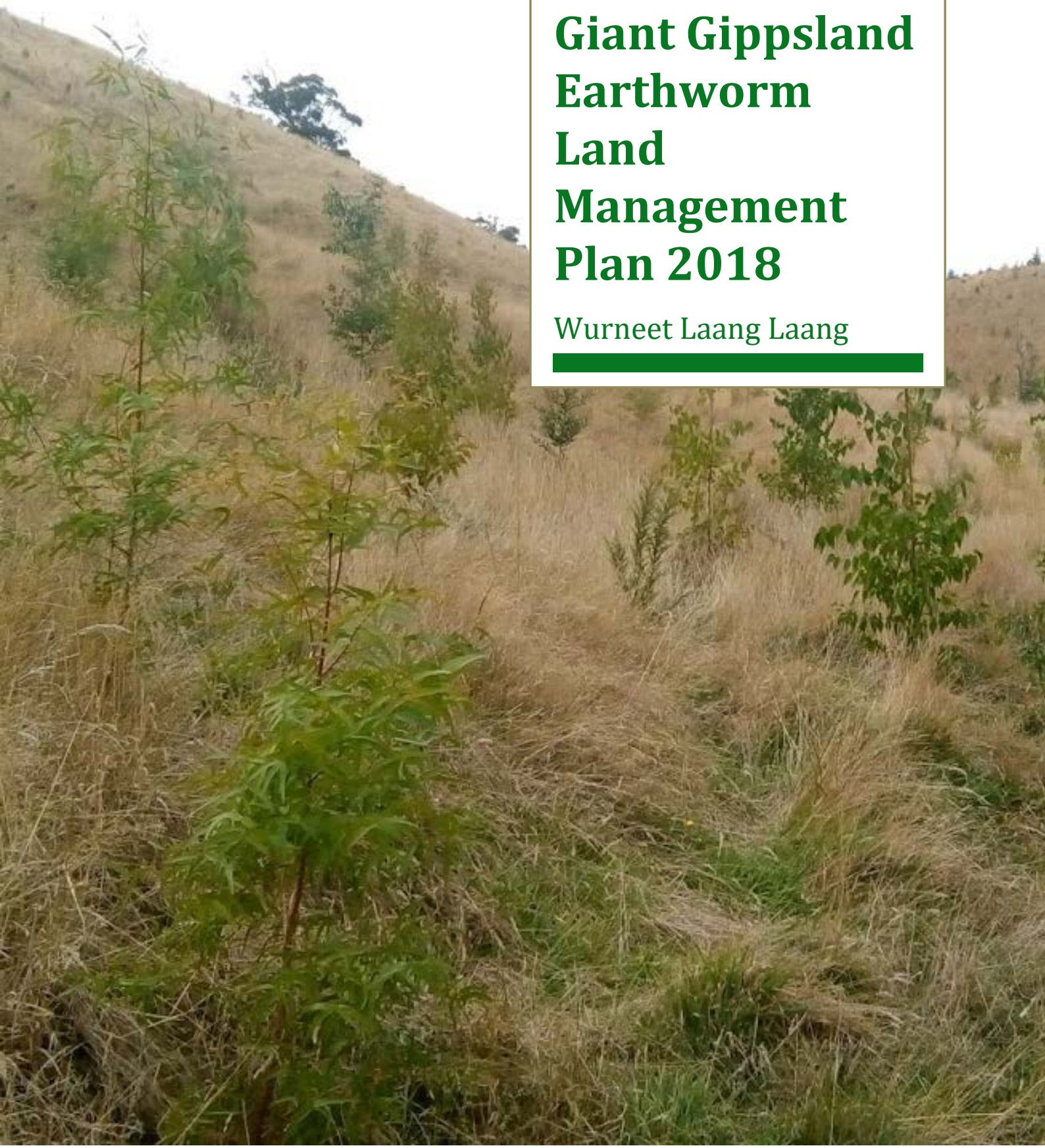
Giant Gippsland Earthworm Land Management Plan 2018

Wurneet Laang Laang



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1. Executive Summary

Giant Gippsland Earthworms (GGE) are a threatened species, endemic to the Strzelecki Ranges. Their population is thought to be in decline, attributed generally to tree clearing post-European settlement. The species are listed as threatened under both Commonwealth and State legislation. Although there is limited biological knowledge, major threats to the species are thought to include soil disturbances, altered hydrology, chemical disturbances and extreme weather/climate change.

Wurneet Laang Laang is a 66-hectare property in the South Gippsland Shire. Greenfleet purchased this property with the aims to create a refuge for many native species and securing bushland in the long term with a 100 year permanence. This property includes two regions of Environmental Significance Overlay Schedule 9 (ESO9) under the South Gippsland Shire Planning Scheme. Under legislation no trees or shrubs are to be planted within these zones to protect the habitat of the threatened species. GGE are thought to be extremely sensitive to soil moisture and it is proposed that conservation actions such as revegetation would cause detrimental impacts, through hydraulic alterations, to vulnerable populations [1]. In this context conservation of GGE pose a problem for traditional conservation methods centred on revegetation. Currently, there are no studies that demonstrate that revegetation has any detrimental impacts to GGE populations, with assumptions remaining speculative.

Surveys undertaken on the property provided no direct evidence for presence of GGE on the property. Both non-intrusive transect walking and small scale soil excavations were undertaken. Results indicated that if any GGE are present on the property, the colonies are unlikely to be of significant scientific importance.

This land management plan proposes to plant native trees and shrubs within the ESO9 regions. Whilst considering the ambiguity surrounding impacts of revegetation on GGE, this planting scheme will be implemented to minimise potential negative impacts. Modifications to the planting scheme will include; no dense tree plantations, minimising physical and chemical soil disturbances, ensuring the water way will retain its integrity and planting to provide co-benefits for other threatened species. This planting scheme is proposed to be planted in early winter, 2019. Greenfleet is committed to ensuring a long-term security for native species and is proposing that planting native trees will be benefit native fauna species. By revegetating this region and restoring native forests the landscape will be transformed back to habitat GGE were believed to thrive in.

2. Aim

The aim of this land management plan is to sequester carbon as well as deliver long term sustainable and native bushland through revegetation. To promote local biodiversity and provide habitat for native threatened species to Southern Gippsland including the Giant Gippsland Earthworm.

3. Species Background

Giant Gippsland Earthworms (GGE) are endemic to the Strzelecki Ranges in western and southern Gippsland [2]. Prior to European settlement, it is thought that GGE were abundant across the Strzelecki Ranges. However, anecdotal evidence over time suggests decline and contraction of their range [3]. These population and range declines have generally been attributed to post-European settlement tree clearing and subsequent agricultural practices [1].

Today, remaining GGE populations are heavily fragmented across a small region of the Bass River Valley around 400 square kilometres, bounded roughly by the townships of Loch, Warragal and Korumburra [1], shown on figure 1. This region has been extensively cleared for agriculture and the majority of remaining GGE populations exist under privately owned agricultural land. There are a few colonies that have been found living within small pockets of remnant vegetation remaining along some stream banks, gullies and road sides [1]. However, Mount Worth State Park is the only known region within the species' range that has significant remnant vegetation and lies on the very eastern extremities of the GGE distribution [1].

The ability of the GGE to survive vegetation clearing indicates that they are a resilient species, as generally native earthworms do not survive land-use transitions from native bush to pasture [4]. This high level of resilience has been attributed to the depth they inhabit under the soil compared to surface earthworms [1]. Indeed, studies have suggested that GGE can move deeper into the soil to avoid desiccation during dry periods [5].

GGE are extremely difficult to study and cannot be readily brought to the surface. This is due to their large size, subterranean habitat and extreme fragility, with an inability to survive even small wounds [4]. Due to these difficulties relatively little is known about this cryptic species [3,6]. Additionally, it has been particularly challenging to accurately measure populations or determine any direct causes of population loss. Overall, the conservation status of Australian earthworms is poorly known [7], with no data on which to base population estimates or trends [2]. Indeed, there remains controversy surrounding the legitimacy of claims for population decline of GGE with some landowners dispute the decline of the species [4].

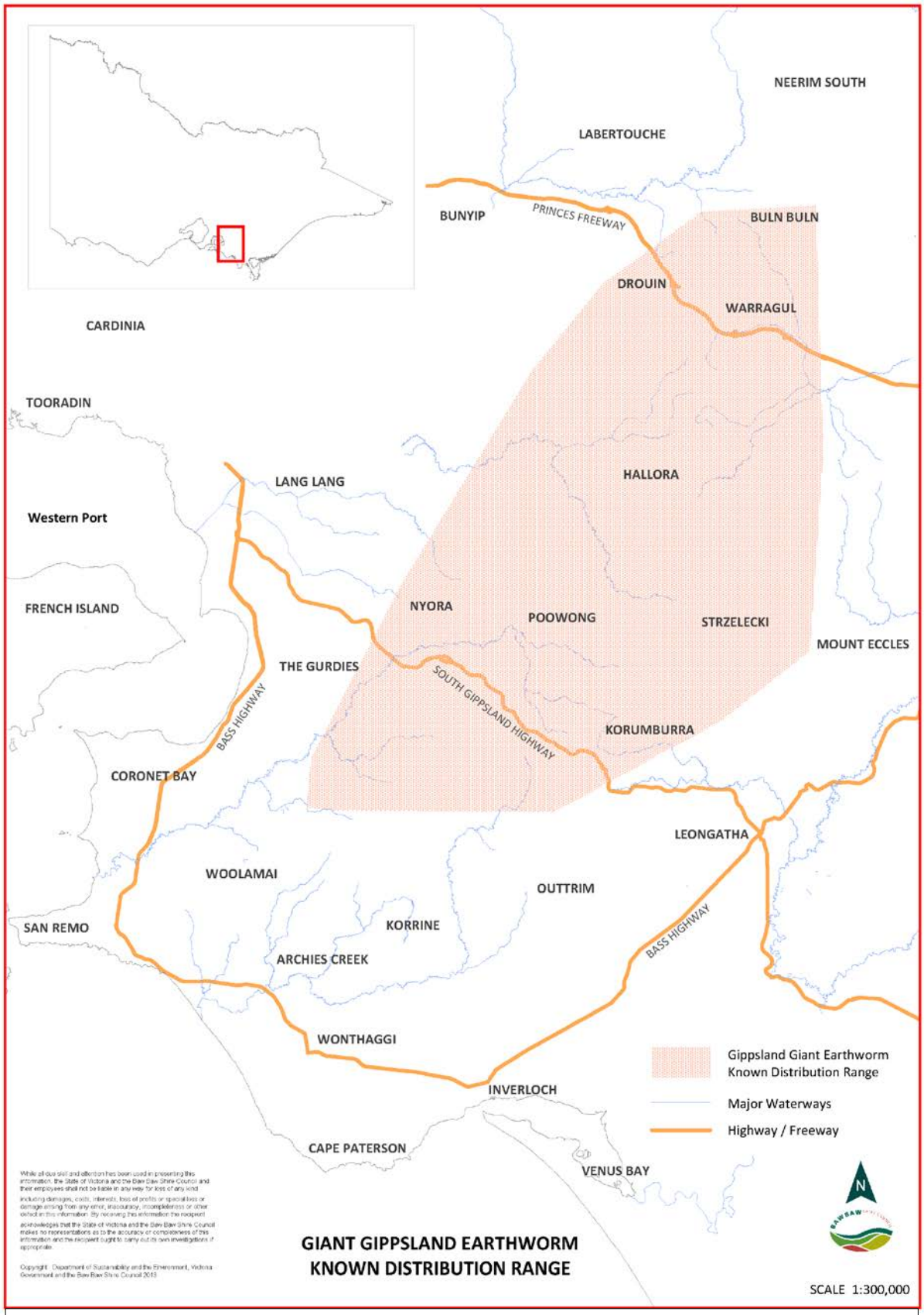


Figure 1: Known distribution of the Giant Gippsland Earthworm, Department of Sustainability and the Environment, Victoria and Baw Baw Shire Council (2013)

3.1 Biology

GGE are one of the largest known species of terrestrial invertebrates [4]. They are comprised of around 300 to 500 body segments and their colour changes from purple in the front third to pinkish-grey for the remaining two-thirds of the body [8] (figure 2). Mature adults have an average length of 80 centimetres, diameter of 2 centimetres and a weight of 200 grams [8]. Lengths of over 1.5 meters have been recorded, however, GGE are measured more commonly by weight as their length can be difficult to measure, with relaxed worms sometimes measuring up to two times longer than contracted [4]. GGE spend their entire life underground in sub-terrain burrows at depths of 1 to 1.5 meters [8], migrating vertically in the soil profile seasonally. Within these burrows GGE move by alternatively contracting and expanding their head and tail ends, producing a loud gurgling or sucking noise [9]. Feeding occurs underground within their burrows on subsoil woody debris [1]. This non-selective diet is considered to have contributed to GGE to surviving vegetation clearing in the region [1]. Living in sub-terrain burrows there are not believed to be any natural predators for this species [9].

Three developmental stages have been identified, classified by the structure of the clitellum[1], and distinguished by weight [4]. It is suggested that sexual maturity is not reached until they are over a minimum of 200 grams [4]. The worms are hermaphroditic but require two individuals to reproduce [10]. A single amber coloured egg cocoon is laid in chambers branching from the adult burrow at an average depth of 22 centimetres [4]. Studies into germination of egg cocoons estimate greater than 12 months [2]. Their breeding season is September-December but reproduction is believed to limited to periods of favourable conditions, of which are not fully known [11].

GGE have a slow growth rate with estimations that individuals take 4.5 years to reach adulthood after hatching [9]. The species is suggested to be long-lived and have low recruitment rates [9]. Due to the highly fragmented nature of their habitat, GGE colonies have been isolated for long time periods, resulting in genetic differences found between colonies [2]. Further, the structure of populations has been found to consist mostly of adults [2]. This raises pressing concerns for aging populations leading to local extinctions. It is predicted that due to the long-lived nature of the worms, low dispersal ability, fragmented populations, low reproduction and recruitment rates, GGE are vulnerable to large changes [4]. Additionally, due to the population dynamics found in colonies, removal of even small numbers of the worms can significantly impact the survival of populations and result in extinction of that population over time [11].

[1] The thickened glandular and non-segmented section of the body wall near the head in earthworms.

Figure 2: Giant Gippsland Earthworm in relation to an Australian 10 cent piece (Photo: Greg Hollis).

3.2 Habitat

The complete distribution of the GGE is unknown. However, they are thought to live predominately underneath cleared agricultural land with a small population within remnant forest in Mount Worth State Park [1]. The population of GGE in a colony can vary significantly, constrained by the amount of available habitat [11]. In some regions few individuals have been observed [11]. The largest known population was uncovered at Loch Hill during road construction, over 800 individuals were translocated from an area of approximately 2500 meters squared [11]. The average density of adult worms in populations is generally low, around two per cubic metre [9]. Studies and surveys have shown that GGE require a set of specific habitat conditions, attributing to their highly fragmented distribution. These habitat requirements include the correct slope, micro-topography, aspect, soil properties and underground hydrological processes [1].

Ideal habitat conditions are controlled mostly by soil type and moisture content. The water balance in burrows is considered important for worm movement and respiration, as they require moisture and free water [11]. Hence GGE are believed to be sensitive to soil moisture [11]. Following this, they are usually confined to 40 meters from stream banks, soaks and wet south facing slopes [6]. They are only found in soils with adequate, but not waterlogged, soil moisture [8]. These are generally found in deep blue-grey clayey soils formed mainly from cretaceous rocks in the Western Strzelecki Ranges and in the alluvial areas derived from this soil to the north and south [2].

There are also visible signs above ground that can aid the identification of suitable GGE habitat. Firstly, the presence of terracettes are often associated with GGE habitat. This association is attributed to the greater micro-relief due to the terracettes, indicating the soils are wetter than surrounding areas and may be subject to 'soil creep' or accelerated terracette formation [11]. Similarly, the presence of the introduced herb Creeping Buttercup (*ranunclus repens)* and Burrowing Crayfish mounds can indicate the presence of suitable GGE habitat as they prefer and often inhabit the same areas [8]. While these indicators can be used to detect potential habitat, hearing the noise the worms make moving though their burrows is the only current method of detecting a GGE colony from the surface.

By utilising these known habitat requirements and characteristics, the Department of Land, Water and Planning (DELWP) have modelled the potential distribution of GGE across both the Baw Baw and South Gippsland Shires. This model only suggests regions with the potential to support populations of GGE and are not verified populations. Indeed, from a survey of 500 sites within suitable habitat only 42 were recorded to contain GGE colonies [9].

4. Conservation Status and Legislation

The legislation listed below are acts and planning provisions which relate to the management of the GGE. These are described further on how they relate to this land management plan.

Table 1: Legislation relating to the protection of the Giant Gippsland Earthworm.

Level	Legislation	Status
Commonwealth	*Environmental Protection and Biodiversity Conservation Act, 1999*	Vulnerable
State	*Flora and Guarantee Act, 1988*	Threatened
	Planning and Environment Act 1987	Protected
	Wildlife Act, 1975	Protected
Council	Environmental Significance Overlay 9	Protected

- *Environmental Protection and Biodiversity Conservation Act, 1999:*
  Under this act, "A person must not take an action that has, will have or is likely to have a significant impact on any of the matters of environmental significance or other protected matters without approval from the Australian Government Minister for the Environment and Energy (the Minister)" [12]. Since proposals within this plan are only relating to small region of the total GGE potential habitat (shown figure 12) it is unlikely to have a significant impact on the GGE population. Hence, this plan will not require approval from the Minister nor violate the EPBC Act.

- *Flora and Guarantee Act, 1988:*
  Under this act, "a permit may be required under the FFG Act for development that could impact GGE and its habitat" [13]. This proposal does not involve development, actions proposed involve habitat restoration. With current knowledge of the species it is unknown

if this proposed action will have an impact on GGE or its habitat. Without this information it is unknown if a permit would be required under the FFG Act.

- *Planning and Environment Act 1987*:
  Within this act, "there is required due consideration for the conservation requirements of threatened species such as GGE" [13]. As mentioned, it is unknown the impacts of this proposal on GGE. However, it is known that this proposal will provide multifaceted benefits for other biodiversity within the region, including endemic threatened species such as the South Gippsland Spiny Crayfish (*Euastacus neodiversus*). This is in line with an objective outlined in the State Planning Policy Framework (VC37): "To provide for the protection of natural and man-made resources and the maintenance of ecological processes and genetic diversity." Further this project will directly benefit the objective of Local Planning Policy Framework clause 21.06-1 "To achieve a measurable net gain in the extent and quality of the Shire's biodiversity". Hence whilst conservation requirements of the GGE relating to revegetation are not known, this proposal would be beneficial for large amounts of biodiversity within the region as it is largely recognised that biodiversity is greatly benefited by tree planting.

- *Wildlife Act, 1975:*
  The main purpose of the *Wildlife Act* relating to this land management plan are, "Promote the protection and conservation of wildlife". As outlined in the *Planning and Environment Act 1987* section above, this proposal will greatly benefit the biodiversity of the region and many native species. Given the 100-year tenure on this property it will provide a long-time security for biodiversity conservation. Again, it is unknown what impacts this may have directly to any GGE colonies present.

- Environmental Significance Overlay 9
  One of the environmental objectives specified within planning overlay ESO9 of the South Gippsland Planning Scheme is, "Ensure that buildings and works avoid negative impacts on individuals, colonies or habitat of the GGE". Included within 'negative impacts' is revegetation of ESO9 mapped regions. Given survey results (section 6) it is unlikely that this proposal will have significant negative impacts to GGE colonies and could potentially futuristically provide a higher quality habitat for GGE as past Ecological Vegetation Classes (EVCs) are restored.

5. Property Background

Wurneet Laang Laang (WLL) is a 66-hectare property situated in South Gippsland, Victoria. The location and dimensions of the property are shown in figures 3 & 4. This property, like much of the Strezlecki region has been cleared and farmed. Greenfleet purchased this property as a retired farm in December 2015 with the aims of restoring this landscape back to its historical vegetation. The following year in June, Greenfleet planted the region with 50,000 native seedlings. The species planted across the property are shown in appendix 1. The areas planted across the property was done in accord with the relevant planning overlays on this property which are explained further below and illustrated in figure 5. Due to the steep topography of the region all plantings were done without the use of machinery and there was minimal ground soil disturbance.

Figure 3: Location of Wurneet Laang Laang in Southern Gippsland, Victoria.

Figure 4: Satellite Image of Wurneet Laang Laang.

Considering planning regulations on the property. Alterations to revegetation have been made. Shown below in figure 5, the total area planted for revegetation is 56.59 ha, remnant vegetation 2.49 ha and an area of 3.2 ha left unplanted from trees.

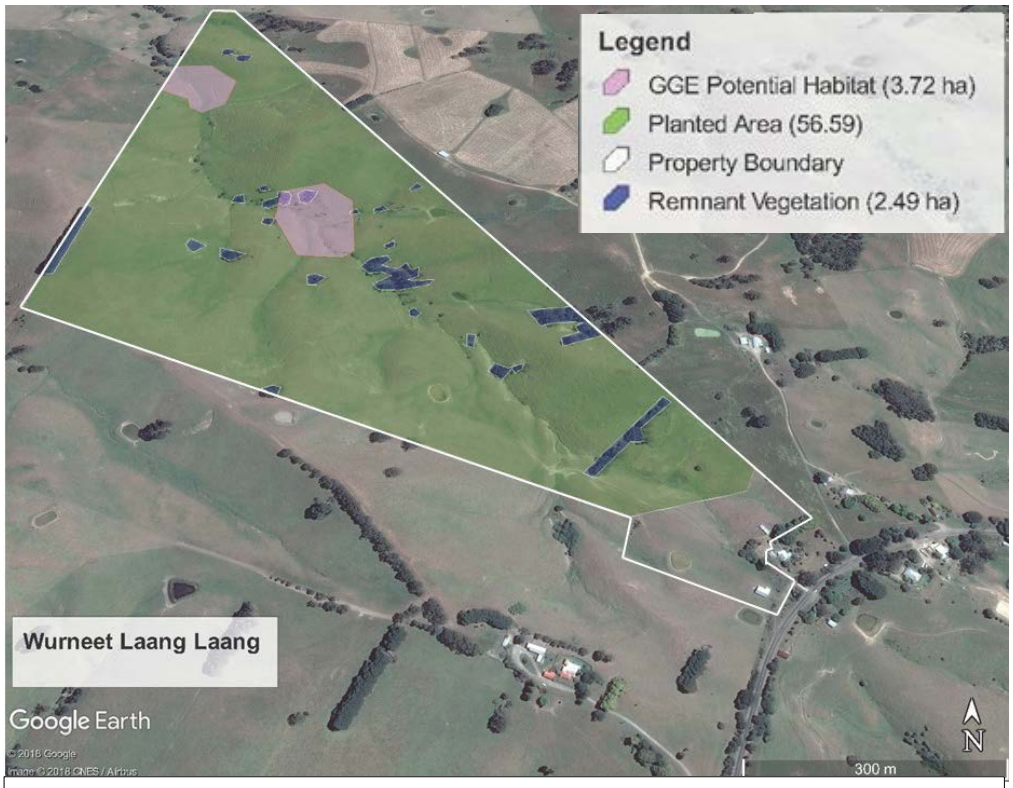


Figure 5: Current Wurneet Laang Laang revegetation regions and zones.

5.1 Ecological Vegetation Classes

Reforestation of this region aims to sequester carbon as well as restore ecosystems, replicating the native forests that once existed. The history of the landscape pre-European settlement is not documented, but similar to the whole Strzelecki region it was believed to have been heavily deforested since the 1870s. This property originally supported two Ecological Vegetation Classes (EVC); Wet Forest EVC which has been depleted and Damp Forest EVC which is endangered with less than 10% of the original extent remaining. The predicted EVC's from 1750 are shown in figure 6.

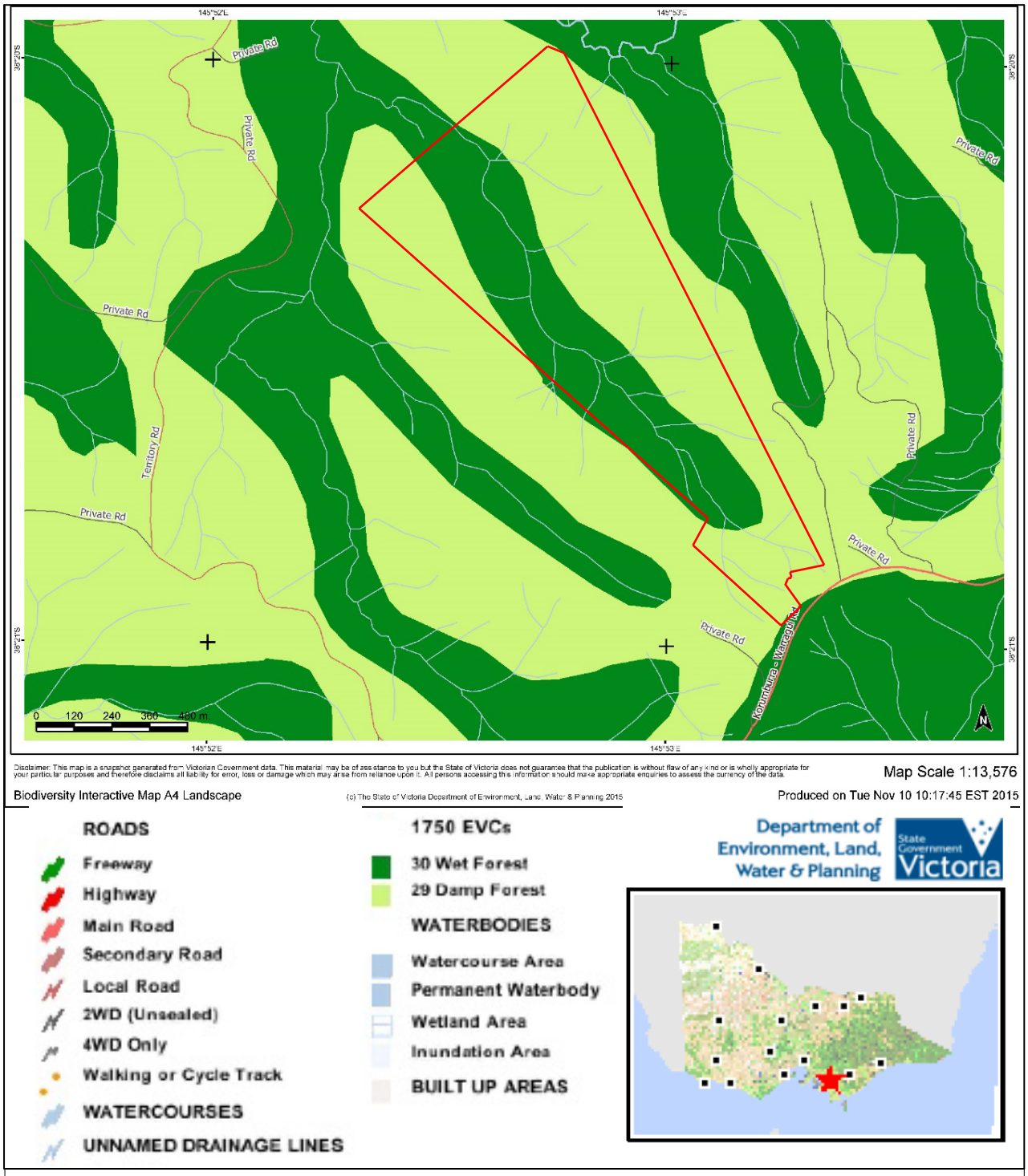
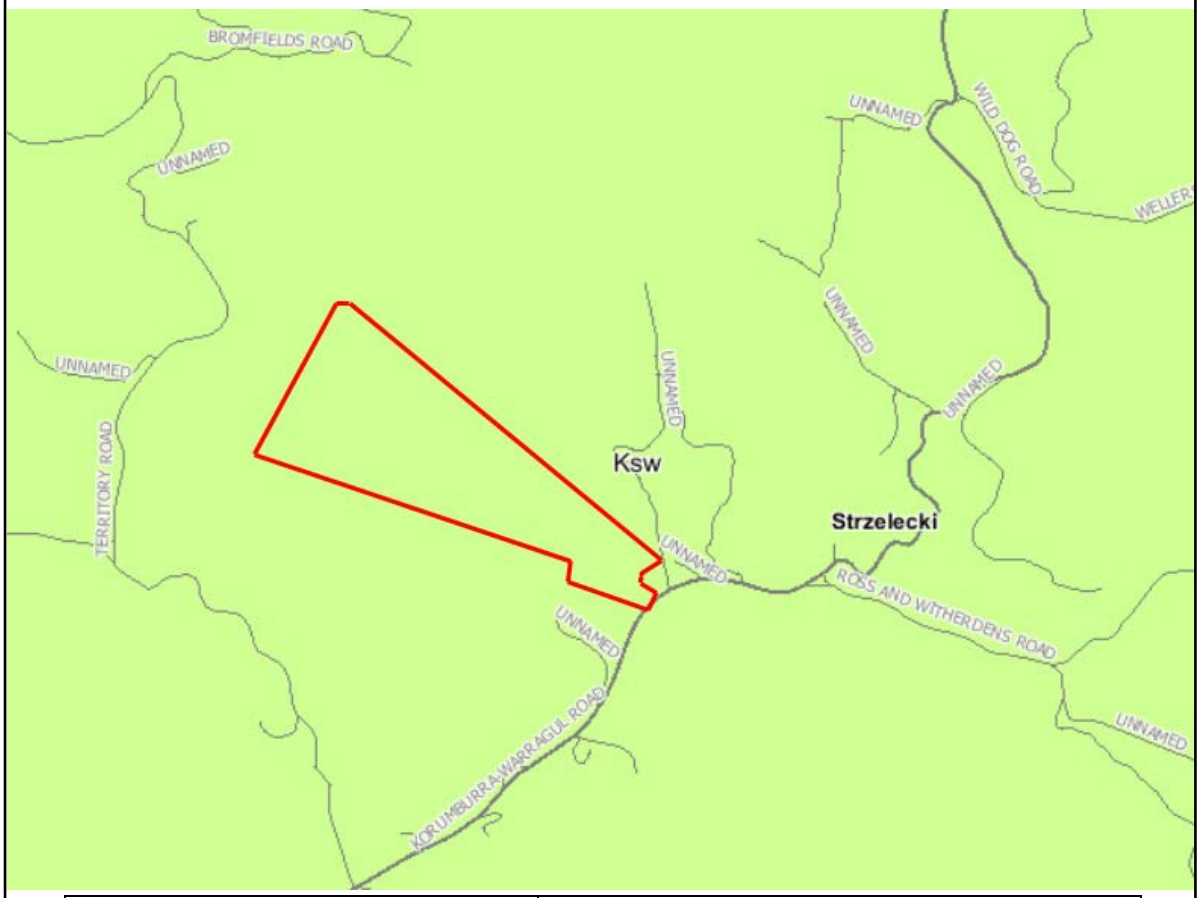


Figure 6: Ecological Vegetation Classes of Wurneet Laang Laang overlayed in red (DELWP, 2015).

5.2 Geology

The geology of WLL is consistent across the entire property. One rock formation exists which is the Wonthaggi Formation, unique to the Strzelecki Ranges. This rock type is from the Cretaceous Period and is shown mapped below in figure 7.

Geological Polygons 250K



Unique Feature Identifier	372
Map Code	Ksw
Old Map Codes	Kls
Unit Type	Rock
Rank	Formation
Unit Name	Wonthaggi Formation
Parents Names	Strzelecki Group
Youngest Age	Cretaceous (Early Cretaceous)
Oldest Age	Cretaceous (Early Cretaceous)
Classification or Environment	Sedimentary (Non-Marine (Alluvial))
Feature Type	ROCK_UNIT
Subtype	Sedimentary
Lithological Description	Fluvial: lithic sandstone, siltstone, minor conglomerate, coal

Figure 7: Geological Map of Wurneet Laang Laang (outlined in red).

5.3 Planning Zones and Overlays

The property is subject to two zones (FZ and PCRZ) and two planning overlays (ESO5 and ESO9) within the South Gippsland Shire. Shown in figures 8 & 9, these were considered by Greenfleet in the initial plantation. Implications of these zones and overlays for WLL are further explained in table 2.

Table 2: Zones and Overlays on the property.

Planning Zone	**Implications**	**Adjustments for WLL**
FZ: Farming Zone	Plantation must not be within 100 m of any land zoned for residential, commercial or industrial use.	Front of the property not planted to allow for any future residential use.
	The plantation must not be within 20 metres of a power line whether on private or public land, except with the consent of the relevant electricity supply or distribution authority.	No trees planted beneath power lines at the front of the property.
	Before deciding on an application to use land, the responsible authority must consider, as appropriate: The need to protect and enhance the biodiversity of the area, including the retention of vegetation and faunal habitat and the need to revegetate land including riparian buffers along waterways, gullies, ridgelines, property boundaries and saline discharge and recharge area.	Application for this land will directly enhance these needs.
PCRZ: Public Conservation and Resource Zone	None applicable	None needed
Planning Overlay	**Implications**	**Adjustments**
ESO5: Areas Susceptible to Erosion	Before deciding on an application, the responsible authority must consider, as appropriate: The need to stabilise disturbed areas by engineering works or vegetation.	Application for this land will directly enhance these needs.
ESO9: Giant Gippsland Earthworm and Habitat Protection	No vegetation can be planted on top of ESO9 regions (which include a 30-meter buffer).	Currently no ESO9 regions planted with trees.

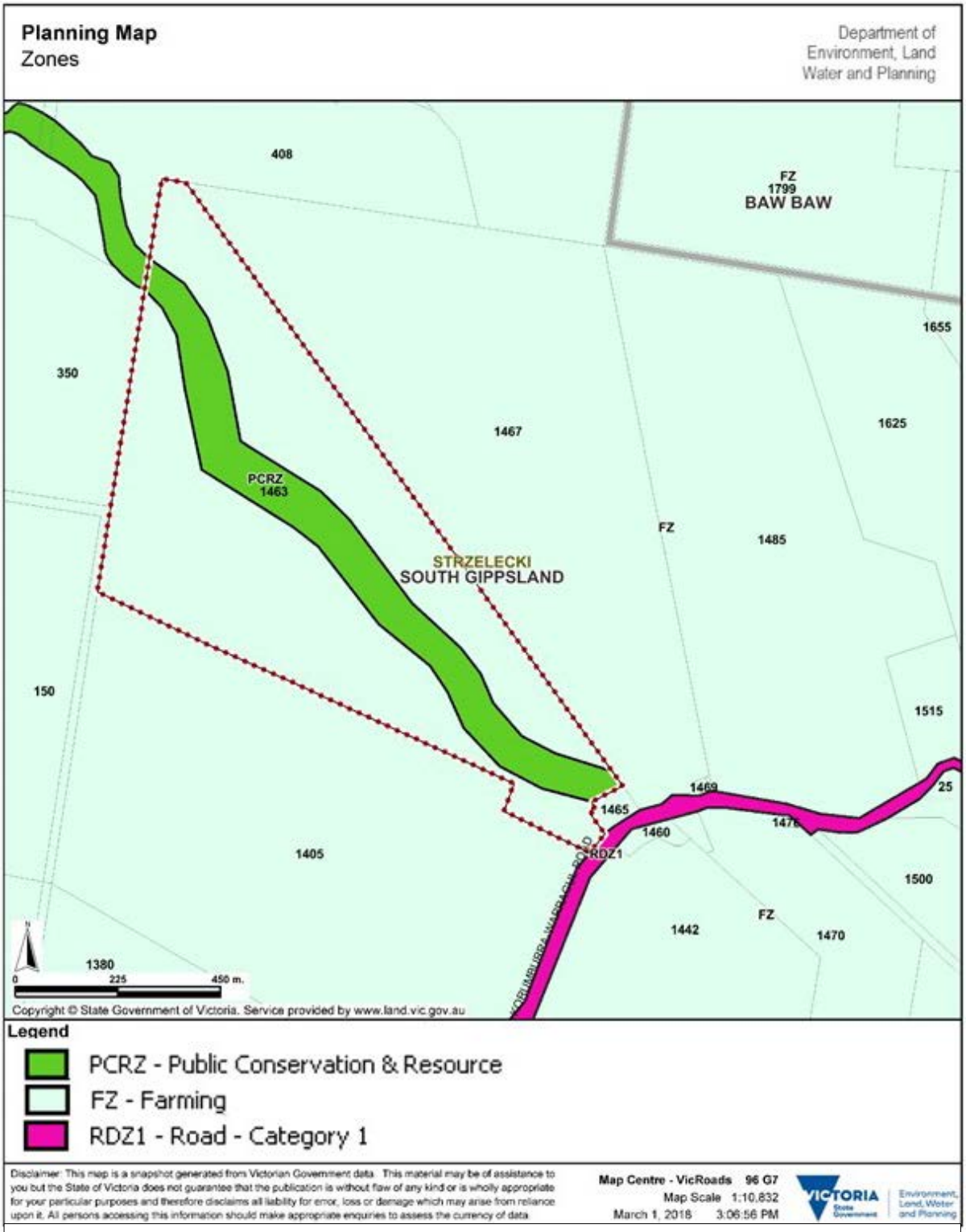


Figure 8: Planning Zones- Wurneet Laang Laang.

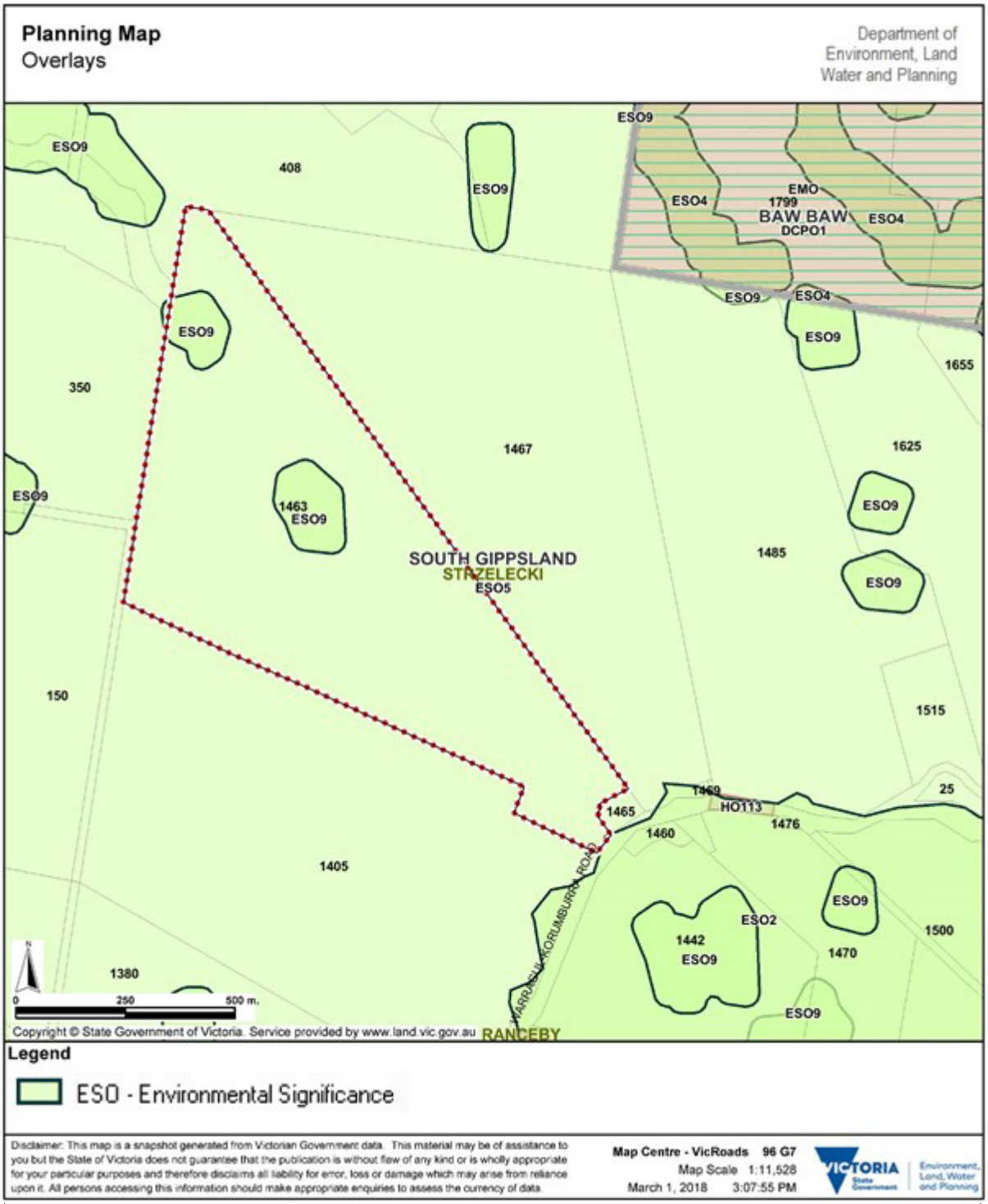


Figure 9: Planning Overlays- Wurneet Laang Laang.

6. Site Surveys

There is no anecdotal or historical knowledge of GGE on the property from any previous landowners. Hence, to determine the presence and/or extent of any GGE colonies at WLL surveys were conducted. These surveys were designed only to determine and record presence/absence data.

The first survey was non-invasive and monitored for sounds made by disturbing the worms in their burrows. Transects were walked across the mapped regions (figure 10), these were kept in closer proximity to the water source as it was more likely GGE would be present [6]. This survey was conducted in accordance with survey methodology outlined in the *Giant Gippsland Earthworm Environmental Significance Overlay Reference Document, September 2015* and is shown in appendix 2. The results of this survey showed no auditable noises heard across any of transects (table 3).

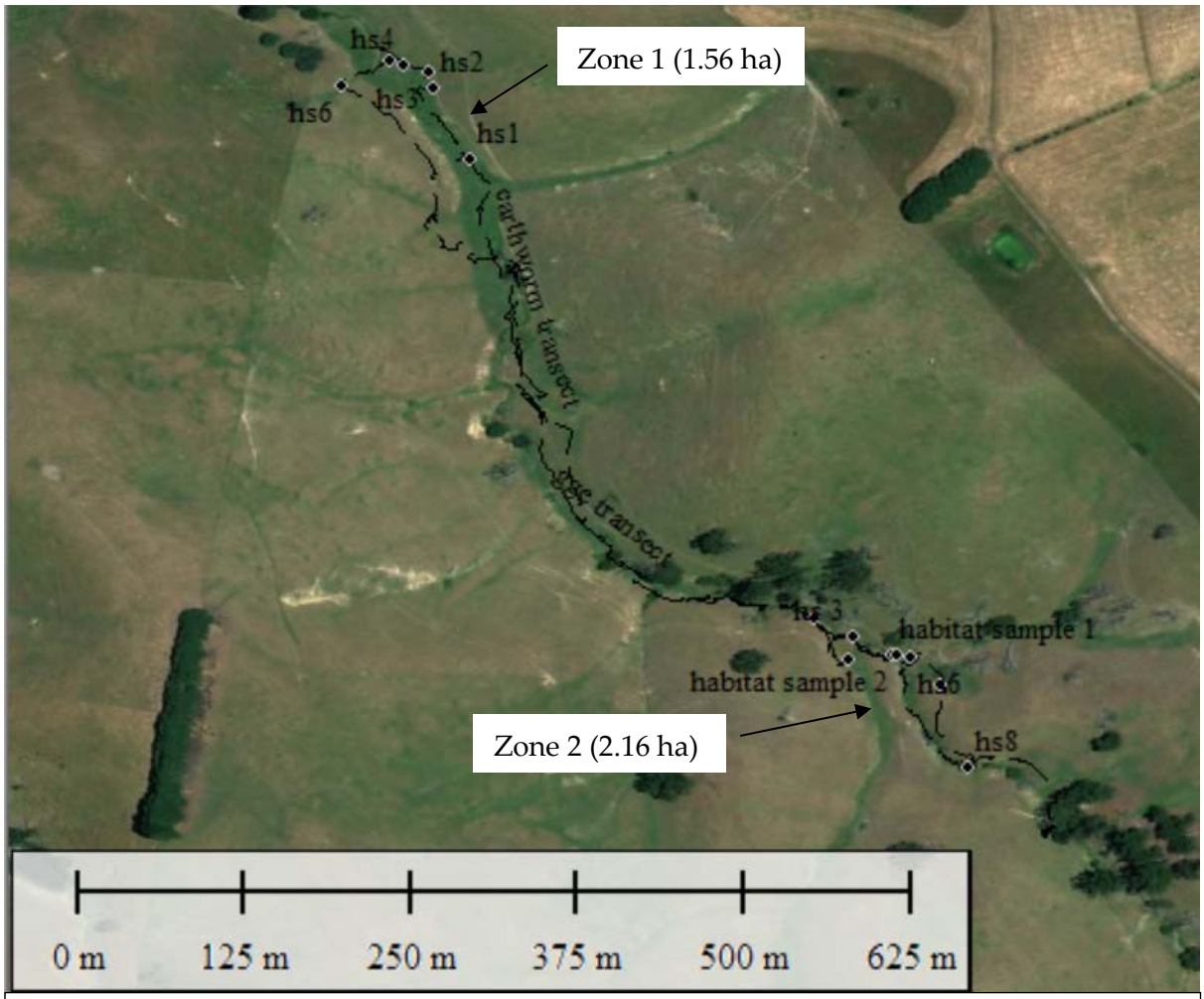


Figure 10: transects mapped out across ESO9 regions.

Table 3: Results from Transect Survey.

Zone 1: 1.56 ha Surveyed 21/02/2018				
	Transect start	**End transect**	**Noises heard Y/N?**	**Location and quantity of noises?**
1	38°20′21.1239″ S 145°52′41.5041″ E	38°20′16.0153″ S 145°52′38.7694″ E	N	Nothing Heard
2	38°20′19.3957″ S 145°52′41.4281″ E	38°20′16.0912″ S 145°52′39.5290″ E	N	Nothing Heard
3	38°20′16.7749″ S 145°52′37.8768″ E	38°20′20.2693″ S 145°52′39.8329″ E	N	Nothing Heard
Zone 2: 2.16 ha Surveyed 21/02/2018				
1	38°20′34.9685″ S 145°52′54.9119″ E	38°20′29.8409″ S 145°52′49.2525″ E	N	Nothing Heard
2	38°20′29.8409″ S 145°52′49.2525″ E	38°20′34.9685″ S 145°52′54.9119″ E	N	Nothing Heard
3	38°20′29.8409″ S 145°52′49.2525″ E	38°20′33.4492″ S 145°52′52.9178″ E	N	Nothing Heard

Failing to detect any GGE on site there was identification of possible, most likely GGE habitat based on above ground indicators (appendix 2). No Burrowing Crayfish mounds were seen. Creeping buttercup was present close to the creek and where their presence aligned with other indicators these were selected as the best markers for ideal GGE habitat. Although it is possible long grass growth may have inhibited identification of other aspects, the most suitable habitat was identified given conditions and knowledge of GGE. Majority of the site selections occurred on the southern aspect and on terracette formation. However, two plots of suitable habitat were identified on the northern side of the creek to avoid exclusion of possible colonies on the northern aspect, because GGE are unable to move through waterlogged soil [2]. Additionally, the floodplain was avoided because GGE cannot survive in water logged soils or areas subject to seasonal flooding [8]. It should be noted, given the survey was conducted during late summer, the landscape appeared very dry. This made identifying areas of permanent soaks or moist patches easier, using ground vegetation as an indicator of soil moisture.

Overall 8 sites were selected in zone 2 and 6 sites in zone 1 (refer to map 8). Given the possible indicators these 14 sites were selected as having the highest potential to have colonies of GGE present. These identified sites were mapped (figure 11). Following this, a second survey was conducted, each of these 14 sites were excavated by hand to 50 x 50 x 50 cm holes to look for any signs of GGE activity. If GGE presence (burrow holes, egg cocoons or casts) were identified, excavation stopped, and observations recorded. Results are shown in tables 4 & 5. Overall 4 out of 14 holes showed signs of past GGE activity, there was no active signs found (wet burrows, egg cocoons, casts), photos of excavations are shown in appendix 3.

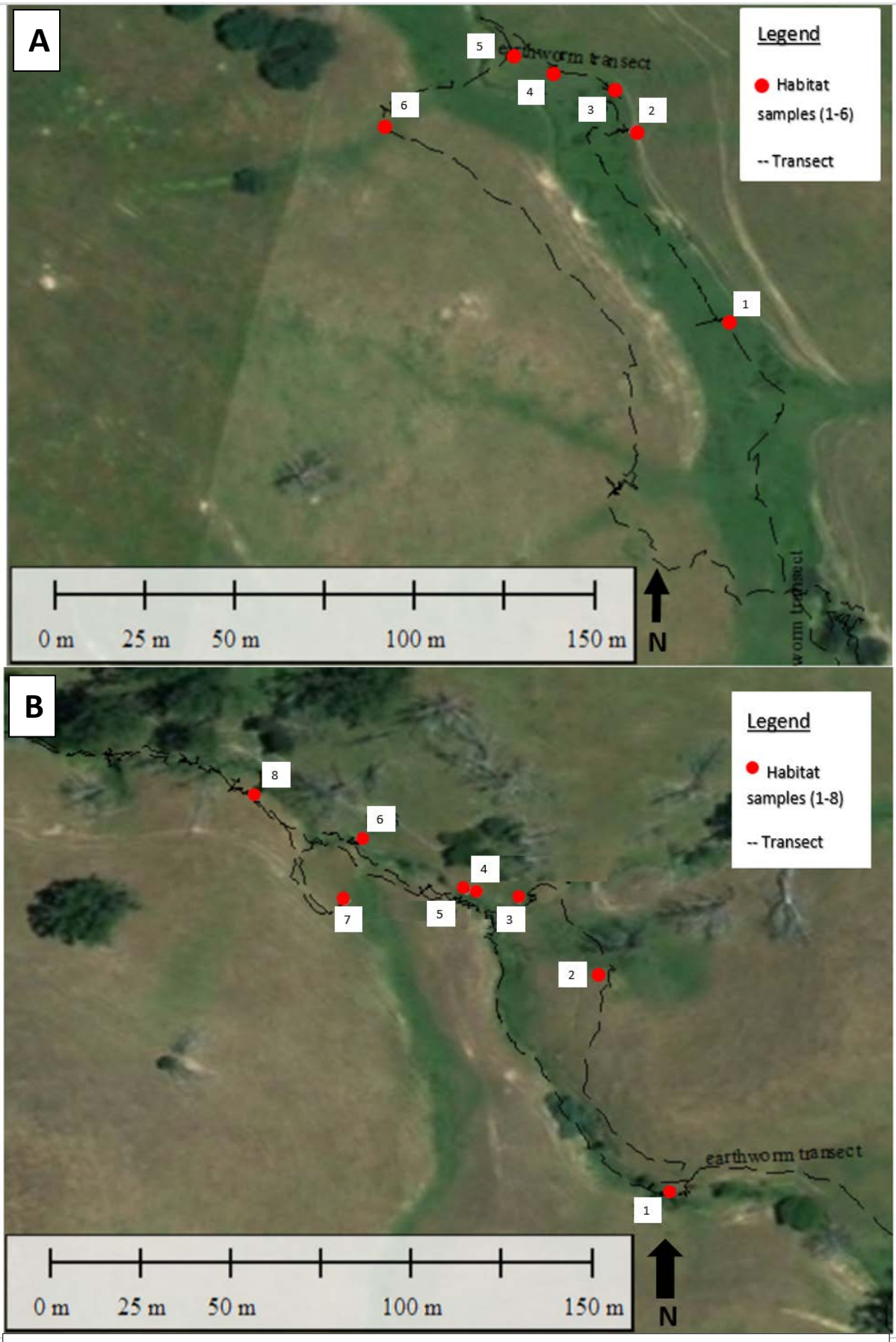


Figure 11: Habitat samples mapped across transects. A) zone 1, B) zone 2.

Table 4: Results from Excavation Surveys, Zone 1.

Zone 1: 1.56 ha Surveyed 20/03/2018				
Quadrant Number	**Location**	**Observation type and description**	**Landscape Habitat Indicators Present**	**Quadrant Soil Depth**
1	38°20′18.7120″ S 145°52′40.9154″ E	Single dry GGE burrow hole uncovered at 350 mm depth.	Steep South Slope, Terracettes.	Hole recorded at 350 mm
2	38°20′16.9268″ S 145°52′40.0038″ E	Nothing observed.	South slope, within soak, Terracettes.	500 mm
3	38°20′16.5280″ S 145°52′39.8329″ E	Nothing observed.	Steep South Slope, Terracettes.	500 mm
4	38°20′16.3666″ S 145°52′39.2821″ E	Nothing observed.	Gentle South Slope, Buttercups, Close proximity to creek.	500 mm
5	38°20′16.2337″ S 145°52′38.9213″ E	Nothing observed.	Gentle South Slope, Close proximity to creek.	500 mm
6	38°20′16.8604″ S 145°52′37.7628″ E	Nothing observed.	Within Soak, Buttercups.	500 mm

Table 5: Results from Excavation Surveys, Zone 2.

Zone 2: 2.16 ha Surveyed 20/03/2018				
Quadrant Number	**Location**	**Observation type and description**	**Habitat Indicators Present**	**Quadrant Soil Depth**
1	38°20′33.3210″ S 145°52′52.9083″ E	Nothing observed.	Steep South Slope, Terracettes.	500 mm
2	38°20′31.3744″ S 145°52′2389″ E	Single dry GGE burrow hole uncovered at 500 mm depth. Burrow casts in soil.	South Slope, Terracettes, Buttercups.	500 mm
3	38°20′30.7002″ S 145°52′51.5600″ E	Nothing observed.	South Slope, Terracettes, Buttercups.	500 mm
4	38°20′30.6338″ S 145°52′51.5039″ E	Nothing observed.	South Slope, Terracettes, Buttercups.	500 mm
5	38°20′30.6195″ S 145°52′51.0899″ E	Single dry GGE burrow hole uncovered at 300 mm depth.	South Slope, Terracettes, Buttercups.	300 mm
6	38°20′30.1495″ S 145°52′50.1451″ E	Nothing observed.	South Slope, Within soak, Teracettes.	500 mm
7	38°20′30.7145″ S 145°52′50.0122″ E	Two dry GGE burrow holes uncovered at 320 mm	Proximity to creek.	320 mm
8	38°20′29.7602″ S 145°52′49.2003″ E	Nothing observed.	Steep South Slope, Terracettes, Proximity to creek.	500 mm

7. Giant Gippsland Colonies at Wurneet Laang Laang

Wurneet Laang Laang contains two regions of identified GGE habitat (ESO9 declared). With a total area of 3.72 ha (zone 1: 1.56 ha and zone 2: 2.16 ha). Both habitat regions are situated in the northern end of the property and are adjacent to the creek which runs roughly through the property centre (refer to figure 9).

GGE habitat is highly fragmented and colonies exist across small areas. The largest GGE colony found to date was at Loch Hill, where over 800 individuals were recovered from a 0.25 ha region [11]. Given this, firstly it is not possible that GGE inhabit this entire 3.72 ha area. Secondly, a large region of these habitat regions overlaps with the flood plain and permanent creek system. Since GGE cannot move through waterlogged soil [2], nor survive in areas subject to seasonal flooding [8]. Therefore, the actual potential GGE habitat is significantly less than the labelled 3.72 ha.

Surveys for GGE on the property returned no active signs of GGE. No noises were heard with transect surveys and only evidence of past GGE activity was uncovered in excavations. Evidence for GGE presence was found in the form of dry burrows. However, they were found very sparsely across quadrants, only present in 28.5% of samples and present as either one or two burrows. Given the results of the survey's conducted on the property (section 6), combined with minimal extent of ESO9 compared to surrounding properties (figure 12), it could be rationally deduced that if any GGE colonies are present of the property they would not be considered significant colonies for sustaining GGE populations into the future.

Alternatively, it is well known that native vegetation supports critical ecosystem services, including stabilising soil, housing beneficial pollinators and other animals, and protecting Australia's extraordinary biodiversity [14]. Hence revegetation of native bushland provided by this project can provide many co-benefits including critical resources for other threatened species of the South Gippsland region.

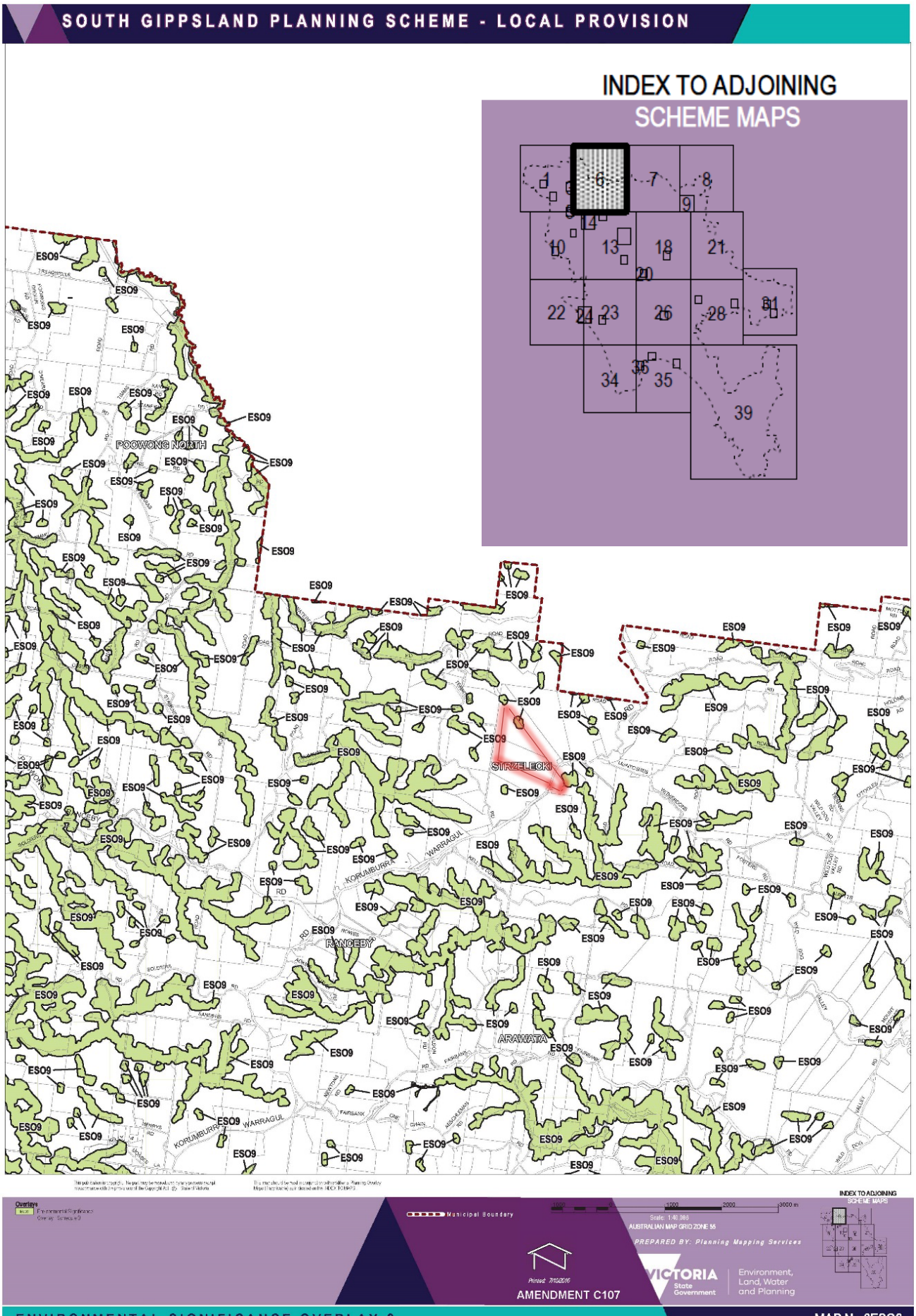


Figure 12: Mapped ESO9 zones across a northern section of South Gippsalnd- Wurneet Laang Laang highlighted.

8. Proposal for Wurneet Laang Laang

Due to the site survey results and the relatively small potential habitat regions on the property, Greenfleet proposes to plant native trees and shrubs across the remaining two mapped ESO9 zones of the property (figure 9). Included in this planting scheme would be small and shallow rooted native understory, species proposed are listed in appendix 1. This planting scheme is proposed to be planted in early winter, 2019. Planting will be carried out to address and minimise key threats to GGE as outlined by GGE Environmental Significance Overlay Reference Document, 2015; soil disturbances, altered hydrology, chemical disturbances and extreme weather/climate change.

8.1 Soil Disturbances

Major soil disturbances can cause physical damage to individual earthworms and egg cocoons [13]. Threats from soil disturbance is usually attributed to large scale disturbances such as excavations, road constructions, dam building and cultivation [13]. This proposal will elicit very limited disturbances to the soil profile. All planting will be done by hand, without the use of ripping machinery. Planting will be done in early winter using tube stock, limiting soil disturbance to the top 10cm of soil. Egg cocoons occur in the soil profile within the top 40cm it is unlikely that any will be uncovered or disturbed in this process. Burrow systems of the GGE are at depths of 1-1.5 meters [8], hence there will be no risk of encountering any adults. However, a copy of unearthed earthworm protocol will be kept present on site. Within this proposal there will be no development or construction on land, no machinery operated, and soil disturbance to the GGE will be negligible overall.

8.2 Altered Hydrology

The hydrology of the soil is thought to be important to GGE [11]. However, there have been no studies conducted into the impacts of revegetation on GGE and impacts remain purely speculative [1]. Local extinction and declines of GGE populations are attributed to clearing of original forests [2]. Nevertheless, it is known that densely planted regenerating Eucalypts require large quantities of water and could potentially alter the hydrology of the region. Given these unknowns and the insignificance found in the survey results, it is proposed planting native trees and shrubs in ESO9 regions.

Vegetation will not be planted densely to minimise hydrology alterations, since it is proposed that dense plantations could be detrimental to GGE [13]. Further, it has been suggested that the GGE are capable of withstanding droughts and soil desiccation by moving lower into the soil profile [5]. Given proximity to a permanent water source and the annual precipitation for the region[2], it is proposed that if GGE colonies are present (not supported by survey results) they may be able to persist during the regeneration phase. Revegetation may additionally provide benefit for this species by canopy cover providing a buffer against long term impacts of changing climate to the soil profile. Since active GGE colonies were not detected there is no conclusive evidence that GGE currently inhabit this region. However, it is believed that GGE were present in high numbers prior to vegetation clearing of the region, declining with tree clearing [1]. In accordance with the aim of this

[2] 1094.2 mm average over 40 years from 1960-2000 (Bureau of Meteorology, 2018)

proposal, Greenfleet intends to ensure long term sustainable and native bushland habitat to promote local biodiversity. Hence, as the effect of revegetation on GGE habitats are unknown and remain speculative [1], Greenfleet would be willing to continue to monitor the property for changes in GGE colonies prior and post revegetation to determine any impacts (section 11).

8.3 Chemical Disturbances

Fungicides, fumigants and insecticides are known to be toxic to earthworms. They have not been, and will not be, used across the property to ensure no contact with earthworms (see appendix 4). Herbicides have been noted to have very low toxicity to GGE when used at prescribed rates [13]. In accordance there is proposed to be used low levels of herbicides in the required regions prior to planting for weed control. Noxious weeds must be controlled under the *Catchment and Land Protection Act, 1994.* By only using small amounts of herbicides and no fungicides, fumigants, insecticides or fertilisers this will ensure if any GGE are present they will not be chemically disturbed through any of these processes.

8.4 Extreme Weather/Climate Change

The confinement of GGE habitat to moist regions near creek banks, soaks and south-facing hill slopes indicates that the species is likely to be sensitive to extreme weather, such as drought or permanent changes to cycles of temperature and rainfall through climate change [13]. Climate change is known to be a serious pressure affecting land management [14] and should not be discounted. Although planting vegetation will result in an initial decrease in soil moisture though tree growth, established forests provide a buffer for soil evaporation rates under increased temperatures [14]. Establishing this buffer is extremely important for Victorian landscapes. Victoria is expected to warm at a slightly faster rate than the global average [15]. Although with levels of uncertainty exist, by 2030, annual average temperatures are expected to increase by around 0.8°C. By 2070, the average annual temperature could increase by 1.4°C or by as much as 2.7°C [15]. Additionally, average rainfall, is expected to decrease by around 4% by 2030 [15]. Given these calculations it can be predicted that GGE habitat is under threat from changing climate. Hence, Greenfleet aims to provide an alternative for protecting GGE habitat by restoring this property back to its historical EVC and restoring a forest canopy cover buffer to protect soil and GGE habitat.

9. Impact Assessment

The overall impact of revegetation within these ESO9 sites, assessed in accordance to the *Giant Gippsland Earthworm Environmental Significance Overlay Reference Document, September 2015.* These are addressed in Table 6 & 7.

Table 6: Impact Assessment Questions 1-5

Proposal Questions 1-5	**Yes/ No**	**Type**	**Extent**	**Impact to GGE**
Impinge upon ESO? How much?	Yes	Revegetation.	3.72 hectares of ESO9, over two distinct zones of 1.56 and 2.16 hectares.	
Physical disturbance to the soil profile within or adjacent to the ESO?	Yes	Limited soil disturbance within the top 10 cm of soil. Hand planting of tube stock. No machinery or ripping.	Minimal disturbance to top soil layer in small isolated patches throughout the ESO9 regions.	No direct impact on habitat, GGE or their cocoons at this shallow depth.
Substantial use of fungicides, herbicides or pesticides, or the release of effluent within or adjacent to the ESO?	No	No fungicides, pesticides, or release of effluent. Small use of herbicides.	Patch weed control.	None.
Alterations to above and below ground hydrology or drainage characteristics within or adjacent to the ESO?	Yes	Revegetation with native species.	3.72 hectares.	Unknown.
Removal or planting of vegetation?	Yes	Revegetation. Planting of native seedlings.	825 stems per hectare.	Unknown.

Table 7: Impact Assessment Question 6

Proposal Question 6	Population extent and size	Genetic distinctiveness	Ecological Value
Significance of any GGE populations identified within or adjacent to the proposed development location?	Unknown. No GGE populations were primarily identified within the proposed revegetation zone through surveys. Survey results suggest evidence for past activity in the region with small numbers of dry burrows found within 4 of 14 sites. ESO9 regions are comparatively small and isolated compared to surrounding properties (figure 12).	Unknown. Lack of evidence found within the survey.	Overall evidence and extent of habitat regions suggest if any GGE colonies are present they would hold limited ecological value due to their isolation and suggested limited populations.

Due to the cryptic nature of this particular species and ambiguity surrounding particular impacts, the level of impact from this proposal on GGE and their habitat is not conclusively known. However, drawing on available scientific knowledge of the species, it can be seen that there will be no direct impact on the species and their habitat through physical or chemical disturbances. Potential alteration of hydrology through planting native flora is the only impact that may be detrimental to GGE and their habitat but this remains speculative. No parts of this proposal will knowingly cause detrimental effects to GGE. As hydrological alterations present the greatest uncertainty in direct impact planting will be approached with caution, ensuring all is done to minimize any potential negative impacts.

10. Mitigation of Negative Impacts

Due to the large degree of uncertainty surrounding the impacts of revegetation on GGE and their habitat Greenfleet will consider measures to avoid, minimise and offset any potential negative impact.

10.1 Avoidance

Avoidance of ESO9 regions is not attainable with this proposal. However, it has been outlined that as the regions cannot be avoided there will be an adjustment in revegetation through minimising potential impacts where possible.

10.2 Minimising

Aspects will be considered to minimise any potential impacts arising from the proposal based on known biological knowledge of the species.

- All planting will be done by hand. There will be no machinery used and no soil ripping. This will allow any physical soil disturbances to be minimal.
- No use of pesticides or fungicides in ESO9 or adjacent zones.
- Only spot spray use of herbicides will be used on weeds within ESO9 or adjacent regions. Minimising any potential chemical disturbance.
- The creek will not be detrimentally impacted, remaining its integrity and water supply to the region.
- No high density of trees will be planted to minimise any hydrology changes.

10.3 Offset Measures

This proposal aims to provide long term security to native biodiversity through restoring EVCs and native bushlands. This is done through on-title agreements that protect flora on the land for 100 years. Currently South Gippsland Shire has 104 listed threatened species [16], of these there are 68 species of threatened bird species [16]. This proposal for revegetation would provide long term security for a large number of bird species. Hence this proposal will futuristically provide habitat for numerous native species, increasing and supportive native biodiversity.

11. Monitoring

Given the survey results taken on the property and the need to research impacts of revegetation on GGE populations, Greenfleet will be willing to monitor for any changes in GGE distribution post revegetation. Proposing to carry out further monitoring for GGE presence at regular intervals over the growth of the plantation. This would be done in accord with survey sampling methodology outlined in *Giant Gippsland Earthworm Environmental Significance Overlay Reference Document, September 2015* and results would be recorded.

12. Conclusion

This land management report outlines a proposal by Greenfleet for restoring a 66 hectare property back to native bushland in the Strzelecki Ranges. Presently, there are two regions of ESO9 totally an area of 3.72 hectares, which have been left unplanted from native vegetation.

Surveys from these mapped ESO9 regions on the property returned no direct evidence for colonies present. Transect walking returned no noises heard of active colonies whilst small excavations of suitable habitat showed 28.5% containing one or two dry burrows (indicating inactivity). Hence, it was rationally deduced that if any GGE are present they would not be considered significant in terms of overall population.

Since it is well known that revegetation of native trees is greatly beneficial for biodiversity, Greenfleet proposes to plant these regions with native trees in an aim to sequester carbon and provide long term sustainable habitat to promote local biodiversity as well as providing resources for other threatened species in Southern Gippsland. However, given that there are uncertainties surrounding this proposal for revegetation and detrimental impacts to any GGE present, there are a number of mitigation strategies that will be implemented outlined in the management plan. These include; not planting high density tree stands, removing any physical and chemical disturbances to the soil, ensuring the water way will retain its integrity and planting to provide co-benefits for other threatened species.

Hence, in this land management plan, Greenfleet propose an alternative method for conserving the habitat of GGE by converting land back to its previous EVC that GGE used to inhabit in large numbers. Additionally, through establishing a native forest on this land, a buffer will be created, reducing impacts from changing climate to soil profiles. Establishment of native forests will promote biodiversity and provide essential ecosystem services for threatened species, securing these resources for a sustainable future.

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15. Appendices

Appendix 1:

Species planted at Wurneet Laang Laang, June 2016.

	Scientific Name	Common Name
Canopy Species (>30m)	*Eucalyptus globulus*	Southern Blue Gum
	Eucalyptus obliqua	Messmate
	Eucalyptus regnans	Mountain Ash
	Eucalyptus strzelecki	Strzelecki Gum
	Eucalyptus viminalis	Manna Gum
Midstorey Species (5-30m)	*Acacia dealbata*	Silver Wattle
	Acacia melanoxylon	Blackwood
	Leptospermum lanigerium	Woolly Tea Tree
	Melaleuca ericafolia	Swamp Paperbark
	Melaleuca squarrosa	Scented Paperbark
	Ozothamnus ferrigneous	Tree Everlasting
	Pomaderris aspera	Hazel Pomaderris
	Prostanthera lasiathos	Christmas Bush
Understorey Species (<5m)	*Acacia verticillata*	Prickly Moses
	Goodenia ovata	Hop Goodenia
	Gynatrix pulchella	Hemp Bush
	Kunzea ericoides	Burgan
	Leptospermum continetale	Prickly Tea Tree
	Olearia lirata	Snowy Daisy Bush
	Solanum avilculare	Kangaroo Apple

Appendix 2:

Survey Methodology

Presence-Absence surveys will be conducted in the following steps which have been written in accordance with the Giant Gippsland Earthworm Environmental Significance Overlay Reference Document.

1. Walk over ground and listen for sounds of the GGE. This should be done in a transect within 40 m of the creek bank within suitable habitat (see section 3.1). Repeat for three transects. If sounds are heard, record presence and location (see section 3.3).
2. Hit ground with spade and listen for sounds of the GGE. Repeat this step along the same transect walked containing the most suitable habitat. If sounds are heard, record presence and location do not progress to step 3, end survey here. If no sounds are heard progress to step 3.
3. If no presence recorded look for, identify and map suitable habitat within the region (see section 3.1).
4. Set up quadrants for regions identified as most suitable habitat. The sites containing the most number of visible favourable attributes should be selected first. The number of quadrants will differ per site depending on survey size and suitable habitat identified. Record location of all sites, listing in order of descending suitability.
5. Starting with the site identified as 'most' suitable, look for presence through excavating soil quadrants of 50 x 50 x 50cm at selected suitable sites. If presence is detected cease digging and record (see section 3.2).
6. Any presence information should be recorded as type (burrow, cast, egg cocoon) and location (see section 3.3).

This survey is designed to determine presence or absence of GGE in the region. It will not determine population size or extent. Excavating should cease if any presence data is found as this indicates the presence of GGE on site and no further survey needs to be taken.

Appendix 3: Excavation Survey Photos (presence only)

Zone 1, Site 1: Single dry GGE burrow at 350 mm.

Zone 2, Site 2: Single dry GGE burrow at 500 mm. Burrow casts in soil.

Zone 2, Site 5: Single dry GGE burrow at 300 mm.

Zone 2, Site 7: Two dry GGE burrow at 320 mm.

Appendix 4: Chemical Spray Sheets

DAILY HERBICIDE REPORT SHEET

ABN: 55 878 947 640
PO Box 504, Wonthaggi VIC 3995
enquiries@envirogain.com.au
www.envirogain.com.au
COL# 807

Record#	Customer	Site name/Location	Date	Hours
INV1280/2203	Greenfleet	1465 Korumburra-Warragul Road, Stzelecki	16/05/16	11.5

Qty of Mixed Herbicide (lts)	Chemical Name	Concentration Rate per 100lts	Weeds Controlled
2000lts	Roundup CT	1lt	Spot Spraying – Revegetation Site Preparation
	Simazine	500g	
	Herbidye	200ml	
	Chemwet	100ml	

Weather Conditions		Equipment Used	Vehicles Onsite	Accredited Person(s) Applying Chemicals			
Conditions:	Windy	☑ QuickSpray	☑ Nissan Patrol	Name:	Michael Shore	Name:	Neil O'Shaughnessy
Temperature °C:	20	☐ Knapsacks	☑ Triton 2012	Name:	Neil Sice	Name:	Sam Sorenson
Wind Speed:	10-15kph	☑ UTV	☑ Triton 2013	Name:	Simon Harrick	Name:	Jeff Cochrane
Wind Direction:	W	☐ Boom	☐ Triton 2014	Name:	Kaz Deppeler	Name:	
		☐ Spot Gun/Dabber	☑ Toyota Hilux				
			☑ UTV				

Did any spray drift occur that could affect people or indigenous vegetation? ☐ YES ☑ NO

If Yes, Detail:

Did any Liquid or Dusts Spill? ☐ YES ☑ NO

If Yes, Action Taken:

Comments & Signature(s):

DAILY HERBICIDE REPORT SHEET

ABN: 55 878 947 640
PO Box 504, Wonthaggi VIC 3995
enquiries@envirogain.com.au
www.envirogain.com.au
COL# 807

Record#	Customer	Site name/Location	Date	Hours
INV1208/2204	Greenfleet	1465 Korumburra-Warragul Road, Stzelecki	17/05/16	10.5

Qty of Mixed Herbicide (lts)	Chemical Name	Concentration Rate per 100lts	Weeds Controlled
2800lts	Roundup CT	1lt	Spot Spraying – Revegetation Site Preparation
	Simazine	500g	
	Herbidye	200ml	
	Chemwet	100ml	

Weather Conditions		Equipment Used	Vehicles Onsite	Accredited Person(s) Applying Chemicals			
Conditions:	O'cast	☐ QuickSpray	☑ Nissan Patrol	Name:	Michael Shore	Name:	Neil O'Shaughnessy
Temperature °C:	15	☑ Knapsacks	☑ Triton 2012	Name:	Neil Sice	Name:	Sam Sorenson
Wind Speed:	10-25kph	☑ UTV	☑ Triton 2013	Name:	Simon Harrick	Name:	Jeff Cochrane
Wind Direction:	W	☐ Boom	☐ Triton 2014	Name:	Kaz Deppeler	Name:	
		☐ Spot Gun/Dabber	☑ Toyota Hilux				
			☑ UTV				

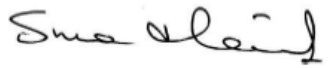
Did any spray drift occur that could affect people or indigenous vegetation? ☐ YES ☑ NO

If Yes, Detail:

Did any Liquid or Dusts Spill? ☐ YES ☑ NO

If Yes, Action Taken:

Comments & Signature(s):



DAILY HERBICIDE REPORT SHEET

ABN: 55 878 947 640
PO Box 504, Wonthaggi VIC 3995
enquiries@envirogain.com.au
www.envirogain.com.au
COL# 807

Record#	Customer	Site name/Location	Date	Hours
INV1280/2205	Greenfleet	1465 Korumburra-Warragul Road, Stzelecki	18/05/16	10.5

Qty of Mixed Herbicide (lts)	Chemical Name	Concentration Rate per 100lts	Weeds Controlled
2500lts	Roundup CT	1lt	Spot Spraying – Revegetation Site Preparation
	Simazine	500g	
	Herbidye	200ml	
	Chemwet	100ml	

Weather Conditions		Equipment Used	Vehicles Onsite	Accredited Person(s)		Applying Chemicals	
Conditions:	Fine	☑ QuickSpray	☑ Nissan Patrol	Name:	Michael Shore	Name:	Neil O'Shaughnessy
Temperature °C:	18	☐ Knapsacks	☑ Triton 2012	Name:	Neil Sice	Name:	Sam Sorenson
Wind Speed:	1-10kph	☑ UTV	☑ Triton 2013	Name:	Simon Harrick	Name:	Jeff Cochrane
Wind Direction:	W	☐ Boom	☐ Triton 2014	Name:	Kaz Deppeler	Name:	
		☐ Spot Gun/Dabber	☑ Toyota Hilux				
			☑ UTV				

Did any spray drift occur that could affect people or indigenous vegetation? ☐ YES ☑ NO

If Yes, Detail:

Did any Liquid or Dusts Spill? ☐ YES ☑ NO

If Yes, Action Taken:

Comments & Signature(s):