



Great Northern Highway



Design Package 3B&C
Bindoon South – 54.5 to 62.3 SLK

Vegetation Rehabilitation Plan

TABLE OF CONTENTS

1. PROJECT AREA	3
1.1 PROJECT LOCATION	3
1.2 ROAD HISTORY	3
1.3 PROPOSED ROADWORKS	3
1.4 VEGETATION DESCRIPTION AT 54.5 TO 62.3 SLK.....	3
TABLE 1 – GNH PROPOSED WORK SECTIONS, 54.85 TO 62.04 SLK.....	5
TABLE 2 – SPECIES LIST GNH, 54.5 TO 62.3 SLK	5
2. REHABILITATION OF THE ROAD RESERVE.....	8
2.1 WEED CONTROL	8
2.2 DIEBACK MANAGEMENT.....	8
2.3 MACHINERY.....	9
2.4 SITE PREPARATION	9
2.5 REVEGETATION.....	9
2.6 ONGOING MAINTENANCE & MONITORING.....	10
TABLE 3 – SPECIES LIST FOR REVEGETATION	11
FIGURE 1 ROADWORKS LOCATION.....	12
FIGURE 2 AERIAL PHOTOS, 54.6 TO 56.5 SLK.....	13
FIGURE 3 AERIAL PHOTOS, 56.5 TO 58.4 SLK.....	14
FIGURE 4 AERIAL PHOTOS, 58.4 TO 60.2 SLK.....	15
FIGURE 5 AERIAL PHOTOS, 60.2 TO 62.1 SLK.....	16
FIGURE 6 AERIAL PHOTO, KAY-PARKINSON PROPERTY ~60.7 SLK	17

1. PROJECT AREA

1.1 Project Location

The project is located on the Great Northern Highway between 54.5 – 62.3 SLK which is approximately 3km south of the town of Bindoon (see [Figure 1](#)) and 65km north of Perth. These road works have been broken up into two sections; Design Package 3B between 54.5-58.05 SLK and Design Package 3C between 59.2-62.3. The section of road in between these two packages (58.05-59.20 SLK) has already been constructed and revegetated in winter 2007.

1.2 Road History

Gradual and steady increases in traffic levels along Great Northern Highway have occurred as a result of ongoing development in the area and to the north. This has resulted in an increased volume of heavy vehicles accessing the North West regions of Western Australia. The alignment and width of the existing road are unsuitable for the increased traffic and these works are required to improve the road amenity and general road safety attributes of this section of Great Northern Highway.

The greater portion of this road was originally built as a 5.8m sealed road in the late 1950's. Widening and resealing took place in the 90's and established the current road widths. The road geometry in this section is now substandard and contains intersections with poor sight distance.

1.3 Proposed Roadworks

- Full Reconstruction of the highway between 54.5-62.3 SLK
- Improved Alignment
- Generally a 9m wide seal on a 11.0m wide carriageway
- Due to the curvilinear geometry, there will be an increased width between Hart Drive to Brockman Bridge of 11m wide seal over a 12.0m wide carriageway
- Turning Lanes at Hart Drive, Chittering Road, Tee Tree Road and Spice Road
- Donaldson's and Anglican Church Accesses

The works will involve clearing an area up to 6.0ha (see aerial photos [Figure 2 to 5](#)).

1.4 Vegetation Description at 54.5 to 62.3 SLK

Beard (1979, 1981, 1990) described the vegetation found in the project area as being predominantly *Corymbia calophylla* (Marri)/*Eucalyptus wandoo* (Wandoo) Woodland on the slopes of the major valley systems, with Flooded Gum and Paperbarks dominating the watercourses in these valleys. Beard comments that the habitat formed by the scarp and valley slopes is often less hospitable than the plateau surface itself, due to the stripping of weathered, water holding layers by geological processes. Also according to Beard, Marri prefers sandier soils, whilst Wandoo predominates where the soil is clayey.

The project area straddles the boundary between Beard's Darling and Chittering Vegetation Systems in the Darling Botanical District. These vegetation systems have the Marri/Wandoo Woodland in common, but in the Chittering System, lower valley slopes are vegetated with York Gum. The remnant vegetation of the project area was found to be predominantly low woodland or low forest of varying density with no York Gum present in the project area.

Heddle et al. (1978) mapped the vegetation of the area as belonging to the following Vegetation Complexes:

- Murray and Bindoon Complex in Low to Medium Rainfall (Major valleys – combining slopes and floors). This complex occurs at the start of the project area and again immediately north of the Brockman River crossing where the valleys are only moderately incised. The distinctive feature of this Complex is the presence of Wandoo Woodland on valley slopes and (Eucalyptus rudis) Flooded Gum and Freshwater Paperbark (*Melaleuca raphiophylla*) along water courses.
- Bindoon Complex. (Major valley floors and scarps). This Vegetation Complex is represented for approximately two kilometers south of the Brockman River crossing, and again immediately south of the Bindoon Townsite. This coincides (approximately) with Beard's Chittering System, and is characterised by York Gum (*Eucalyptus loxophleba*) on lower valley slopes, flanked by Wandoo higher upslope.
- Nooning Complex. (Major valley floors and scarps). This complex is restricted to the upper valley floors of the Brockman River. This complex abuts the project area where it traverses the Brockman River valley, and occurs where the highway crosses the river. The distinctive feature of this Complex is the presence of low open forest of Swamp Sheoak (*Casuarina obesa*) and of the presence of Swamp Sheoak with Flooded Gum and Freshwater Paperbark along streams.

More recently Griffin (1992) completed a detailed floristic survey and analysis of remnant vegetation in the Bindoon to Moora areas, including the project area. His survey included sites at Lakes Chittering and Needoonga. This study showed that the area covered is one of the floristically rich areas of Western Australia, recording 1032 native species. Along with this rich floristic diversity is a large variation in vegetation types. Griffin defined 45 major types all with a number of sub-types or variants.

In and around the project area, only remnants in varying condition remain due to a long history of agricultural settlement. See [Table 2](#) for a full species list in the vicinity of the roadworks.

Table 1 – GNH Proposed Work Sections, 54.85 to 62.04 SLK

Section	Location (SLK)	Length (Km)	Description of Proposed Works
1	54.85 – 55.85	1.0	Widen and overlay including reconstruction of Parking Bay
2	55.85 – 56.90	1.05	Reconstruction and improve intersection with Hart Drive and Chittering Road
3	56.90 – 58.64	1.74	Reconstruction and realignment (Donaldson's section)
4	58.64 – 59.16	0.52	Improve intersections with Tee Tree Road and Spice Road
5	59.16 – 59.22	0.04	Brockman Bridge widening and pavement works
6	59.22 – 60.50	1.28	Reconstruction and realignment including intersection with Flat Rocks Road
7	60.50 – 62.04	1.54	Widen, overlay and construction of southbound passing lane

Table 2 – Species List GNH, 54.5 to 62.3 SLK

FAMILY	TAXON	ROAD SECTION (Ref Table 1 above)						
		1	2	3	4	5	6	7
Family Zamiaceae	Macrozamia riedlei	x			x			x
Family Typhaceae	* Typha orientalis							x
Family Poaceae	* Andropogon distachys							x
	* Avena sp.	x	x		x		x	x
	* Briza maxima	x	x		x			
	* Bromus hordeaceus					x	x	
	* Cynodon dactylon				x	x	x	x
	* Ehrharta calycina				x		x	
	* Ehrharta longiflora			x	x			x
	* Eragrostis curvula			x	x	x	x	x
	* Hordeum leporinum						x	x
	* Lagurus ovatus	x	x		x			
	Neurachne alopecuroidea		x					
	Paspalum dilatatum				x			
	Pennesetum clandestinum							x
	* Phalaris aquatica					x	x	x
	* Poa annua	x					x	
	* Sorghum halepense							x
	* Stenotaphrum secundatum			x		x		
Family Cyperaceae	Cyperus sp.				x			
	Lepidosperma gracile	x	x					
	Lepidosperma sp.				x			
Family Restionaceae	Alexgeorgia arenicola				x			
	Meboldinia coangustus				x			
Family Juncaceae	Juncus pallidus							x
Family Dasypogonaceae	Acanthocarpus preissii	x	x					
Family Phormiaceae	Dianella revoluta	x	x		x			
	Stypandra glauca	x	x	x	x			
Family Anthericaceae	Agrostocrinum scabrum		x		x			
	Caesia parviflora				x			
	Thysanotus dichotomus						x	
	Xanthorrhoea preissii	x	x	x				x
Family Haemodoraceae	Haemodorum sp.				x			
Family Iridaceae	Orthrosanthus laxus				x			

FAMILY	TAXON	ROAD SECTION (Ref Table 1 above)						
		1	2	3	4	5	6	7
	* Romulea rosea	x	x		x		x	
	* Watsonia bulbifera			x	x	x	x	
Family Casuarinaceae	Allocasuarina fraseriana	x	x	x				
	Casuarina obesa				x	x		x
Family Proteaceae	P Adenanthos cygnorum subsp. chamaeophyton		x					
	Banksia grandis				x			
	Banksia littoralis				x			
	Dryandra nivea				x			
	Dryandra sessilis	x	x	x				
	Dryandra squarrosa subsp. squarrosa				x			
	Grevillea synaphea			x	x			
	Hakea prostrata				x		x	
	Hakea undulata				x			
	Synaphea gracillima			x	x			
Family Polygonaceae	* Muehlenbeckia adpressa		x		x			
	* Rumex ?crispus					x	x	x
	* Rumex sp.			x				
Family Amaranthaceae	Ptilotus drummondii	x	x					
	Ptilotus manglesii				x			
Family Ranunculaceae	Clematis pubescens	x	x					
Family Fumariaceae	* Fumaria capreolata		x	x	x	x		
Family Brassicaceae	* Raphanus raphanistrum				x		x	x
Family Droseraceae	Drosera erythrorhiza				x			
Family Pittosporaceae	Sollya heterophylla				x			x
Family Mimosaceae	P Acacia drummondii ?subsp. affinis				x			
	Acacia lateriticola				x			
	* Acacia podalyriifolia				x			
	Acacia pulchella	x	x	x	x			
	Acacia saligna			x		x	x	x
Family Papilionaceae	Bossiaea eriocarpa	x	x					
	* Chamaecytisus palmensis	x			x	x	x	
	Daviesia longifolia			x	x			
	Daviesia preissii				x		x	
	Dillwynia sp. A (Marchant et. al.1987)			x	x			
	Gastrolobium capitatum			x	x			
	Gompholobium marginatum				x			
	Jacksonia sternbergiana			x				
	Kennedia prostrata	x	x		x			
	Kennedia stirlingii				x			
	* Lupinus angustifolius				x			
	* Lupinus cosentinii				x			
	* Trifolium arvense	x				x	x	
	* Vicia sativa			x				x
	Viminaria juncea						x	

FAMILY	TAXON	ROAD SECTION (Ref Table 1 above)						
		1	2	3	4	5	6	7
Family Geraniaceae	* Erodium sp.				x		x	
Family Oxalidaceae	* Oxalis pes-caprae						x	x
	* Oxalis purpurea						x	x
Family Euphorbiaceae	* Ricinus communis	x	x					
	* Euphorbia sp.				x			
	Phyllanthus calycinus	x	x	x	x			
Family Anacardiaceae	* Schinus terebinthifolius				x			
Family Rhamnaceae	Trymalium ledifolium				x			
Family Sterculiaceae	Thomasia foliosa	x	x					
Family Dilleniaceae	Hibbertia commutata	x	x	x	x			
	Hibbertia hemignosta (= H. enervia)				x			
	Hibbertia sp.		x					
Family Lythraceae	* Lythrum hyssopifolia							x
Family Myrtaceae	Corymbia calophylla	x	x		x			x
	Eucalyptus rudis	x	x	x	x	x	x	x
	Eucalyptus wandoo	x	x		x			
	Hypocalymma angustifolium						x	
	Melaleuca lateriflora				x			
	Melaleuca preissiana							x
	Melaleuca raphiophylla			x	x	x	x	x
	Melaleuca teretifolia				x	x	x	
Family Apiaceae	* Hydrocotyle ranunculoides				x	x		
Family Epacridaceae	Astroloma pallidum	x	x					
Family Primulaceae	* Anagallis arvensis v. arvensis	x	x		x	x	x	x
Family Oleaceae	* Olea europaea							x
Family Lamiaceae	* Stachys arvensis				x		x	
Family Solanaceae	* Solanum nigrum	x		x	x	x	x	x
Family Scrophulariaceae	* Kickxia elatine	x			x		x	x
Family Rubiaceae	Opercularia vaginata			x	x			
Family Goodeniaceae	Dampiera trigona				x			
	Lechenaultia biloba	x	x		x			
Family Asteraceae	* Arctotheca calendula				x		x	x
	* Cotula coronopifolia				x			
	* Hypochaeris glabra	x	x				x	x
	* Lactuca serriola							x
	* Senecio sp.				x			
	* Sonchus oleraceus						x	x
	* Ursinia anthemoides				x			

2. REHABILITATION OF THE ROAD RESERVE

The revegetation along this section of highway will be contained within the road reserve and comprise a mix of direct seeding and plantings with locally occurring indigenous species. The total area to be revegetated is 9.9ha made up of: new road batters = 2.8ha, existing road reserve = 4.0ha, Donaldson's property = 0.31ha, Perth Diocesan Trustees property = 0.99ha and infill planting on Kay-Parkinson's property = 1.8ha. Outside of the road reserve 3.5ha will be revegetated on Clayton's property, which is an agreement for using the area as the 3b laydown site.

The revegetation site has been broken into 3 zones with different height species planted in each zone.

Zone 1 – Closest to Road (species < 600mm height)

Species to be planted as tube stock at a rate of 1 plant per 2m²

Species to be sown from seed at a rate of 3kg per hectare

Zone 2 – Transition Zone (species < 4m height)

Species to be planted as tube stock at a rate of 1 plant per 3m²

Species to be sown from seed at a rate of 3kg per hectare

Zone 3 – Against Road Reserve Boundary (no species height restrictions)

Species to be planted as tube stock at a rate of 1 plant per 4m²

Species will be sown from seed at a rate of 3kg per hectare

The revegetation to take place on Kay-Parkinson property is in the form of infill planting where no height restrictions apply - see aerial photo [Figure 6](#).

The species list for the revegetation (see [Table 3](#)) is very extensive and not all of these species may be available at the time of seeding/planting. It is anticipated this may be the case with several of the understorey species and if this occurs more of the species which are available will be added to the mix to compensate. To provide food plants for any Carnaby's Black Cockatoos in the area Eucalyptus, Allocasuarina, Banksia, Calothamnus and Dryandra species must make up part of the revegetation species list.

2.1 Weed Control

The revegetation site will be sprayed with a residual herbicide (e.g. Simazine) if there is sufficient time before the planting season (greater than 6 months). This will reduce the amount of weeds present, however if planting is to take place immediately no residual herbicide will be sprayed as this will stop any native seedlings emerging.

Once the annual grasses emerge weeds will be sprayed with herbicide (e.g. Glyphosate) several weeks before planting. Roundup Bi-Active will be used in the areas closer to waterways and all herbicide be applied from a boom spray unit where accessible and hand sprayed in other areas.

2.2 Dieback Management

The project area falls within the 400-600mm rainfall zone in which dieback may occur. Hygiene measures will be in place to reduce any possible spread if the disease is present, which include:

- All machinery, plant and equipment shall be free of soil and vegetative matter prior to entering the road reserve and when leaving the site.
- No entry will be permitted to vegetated areas outside of the road reserve boundary.
- The movement of soil in wet conditions will be avoided or kept to an absolute minimum where the work is essential.
- Soil or mulch brought from offsite into the revegetation area must be from a dieback free location.

These hygiene measures will also help to reduce the spread of weeds.

2.3 Machinery

- Fuel storage will not be required on site.
- Oil changes will not be carried out within the road reserve area.
- Any soil contaminated by oil or fuel will be removed from site and disposed of at an approved location.
- All machinery to be fitted with fire extinguishers.
- The road reserve and surrounding area will be kept free of rubbish and litter.

2.4 Site Preparation

The site will be ripped along the contour at 1-metre intervals and to a minimum depth of 300mm before planting/seeding. This ripping is to create niches for the seed to lodge and encourage root development as well as catching surface water and preventing erosion. Any large boulders and wood debris brought to the surface during ripping will be left for future fauna habitats.

Before planting the site topsoil and mulched vegetation will be spread across the revegetation site to a minimum depth of 50mm and not more than 100mm thick. The topsoil and mulch will be blended at a 5:1 ratio before spreading and applied in one application.

Road batter slopes will not be ripped as they are to be benched and will be priority sites for available weed free topsoil and mulch.

2.5 Revegetation

Direct seeding will take place at an appropriate time for maximum germination once the road works are complete. Mixed seed will be spread at a minimum rate of 3kg/hectare and bulked up with vermiculite and/or sawdust in order to improve evenness of spread. At this rate 24kg will be required to cover the 8.1ha site.

Planting will occur concurrently with the seeding at between 2,500-5,000 stems per hectare (1 plant per 2-4 m²) depending on the planting zone (1, 2 or 3). Seedlings are to be 'hardened off' before planting and at this rate approximately 30,000 stems will be required to cover the 9.9ha site.

Fertiliser for direct seeding and planting won't be used due to the proximity to the Chittering Lakes 'A' Class reserve. If it is felt that fertiliser would benefit the revegetation in an area away from the lakes prior to seeding, fertiliser with a high nitrogen content and phosphorous content lower than 3% (e.g. Agras No. 1) may be applied at a maximum rate

of 120kg/hectare. Seedlings could possibly be fertilised with slow release tablets placed 100mm from the roots and 100-150mm below the surface (eg Baileys 'Apex Native').

Rates have been chosen based on a species breakdown of roughly 20% upper storey, 30% middle storey and 50% understorey, ground covers and climbers. This means that if 50 species are being used 10 would be larger trees, 15 smaller trees and shrubs and 25 lower understorey plants.

This percentage split of 20, 30, 50 also applies to the breakdown of seed and stem quantities. For 3kg/ha of seed 0.6kg is for upper storey, 0.9kg for middle storey and 1.5kg for understorey and with 2,500 stems/ha 500 are upper storey, 750 middle storey and 1,250 would be understorey species.

2.6 Ongoing Maintenance & Monitoring

Monitoring of the revegetation effort will determine if follow up plantings will be required. The revegetation site will be inspected 12 weeks after planting/seeding and during the following autumn to assess if winter plantings are required. One year after revegetation there should be 2,000 stems per hectare and no less than 5 species present per 1000m².

If required follow up herbicide applications will occur on problem weeds for up to three years after planting/seeding. This herbicide will be spot sprayed on the weeds by hand to avoid overspray onto native plants and will allow these plants to develop without competing with weeds. During these weed inspections for three years after planting/seeding the health and quantity of the revegetation will also be monitored. This monitoring may result in further plantings if species density or diversity has diminished.

Table 3 – Species List for Revegetation

Species	Zone 1		Zone 2		Zone 3	
	Seed	Seedlings	Seed	Seedlings	Seed	Seedlings
Acacia drummondii						✓
Acacia drummondii subsp. affinis				✓		
Acacia lateriticola				✓		
Acacia pulchella				✓		
Acanthocarpus preissii	✓		✓		✓	
Adenanthos cygnorum, subspecies chamaephyton				✓		✓
Allocasuarina fraseriana						✓
Banksia grandis						✓
Bossiaea eriocarpa		✓		✓		✓
Callistemon phoeniceus				✓		✓
Calothamnus quadrifidus				✓		✓
Casuarina obesa						✓
Corymbia calophylla						✓
Dianella revoluta	✓		✓		✓	
Daviesia preissii	✓		✓		✓	
Dryandra nivea				✓		
Dryandra sessilis				✓		
Eucalyptus loxophleba						✓
Eucalyptus rudis						✓
Eucalyptus wandoo						✓
Grevillea bipinnatifida				✓		
Grevillea synapheae				✓		✓
Hakea lissocarpha				✓		✓
Kennedia prostrata		✓				
Melaleuca lateriflora						✓
Melaleuca preissiana						✓
Melaleuca raphiophylla						✓
Melaleuca uncinata						
Xanthorrhoea preissii			✓		✓	

Zone 1 – Closest to Road (species < 600mm height)

Species to be planted as tube stock at a rate of 1 plant per 2m²

Species to be sown from seed at a rate of 3kg per hectare

Zone 2 – Transition Zone (species < 4m height)

Species to be planted as tube stock at a rate of 1 plant per 3m²

Species to be sown from seed at a rate of 3kg per hectare

Zone 3 – Against Road Reserve Boundary (no species height restrictions)

Species to be planted as tube stock at a rate of 1 plant per 4m²

Species will be sown from seed at a rate of 3kg per hectare

FIGURE 1 ROADWORKS LOCATION

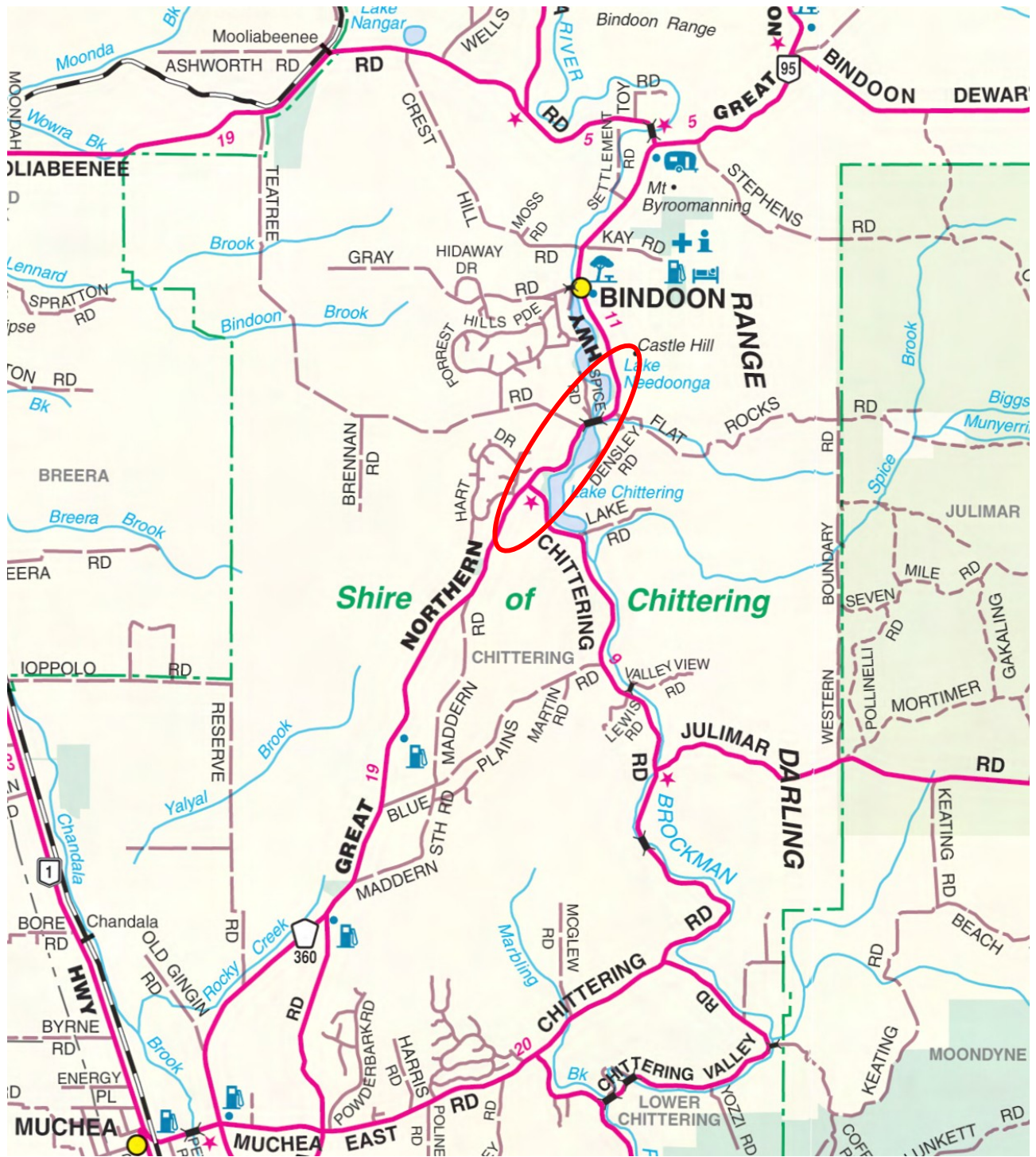


FIGURE 2 AERIAL PHOTOS, 54.6 TO 56.5 SLK

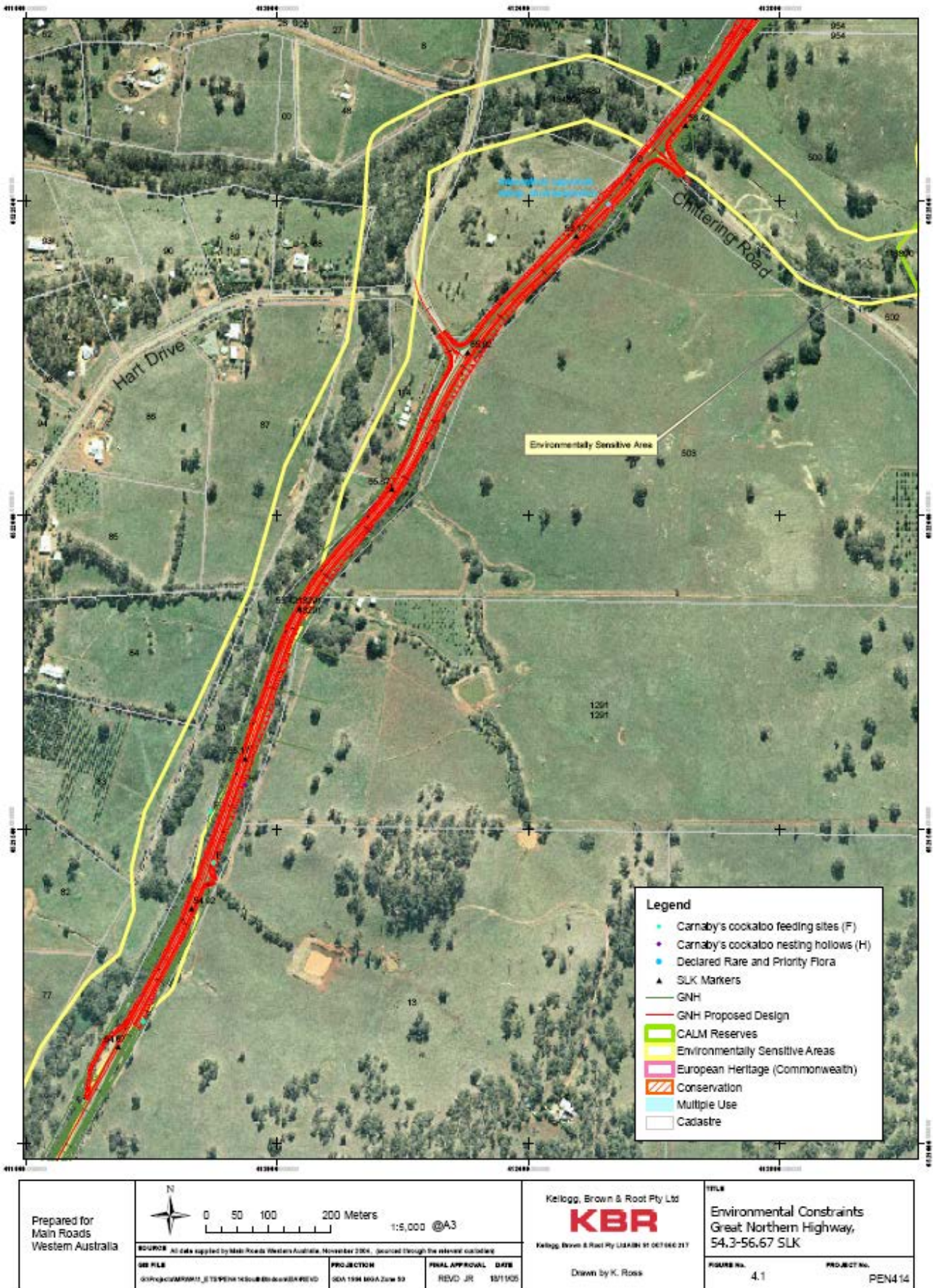


FIGURE 3 AERIAL PHOTOS, 56.5 TO 58.4 SLK

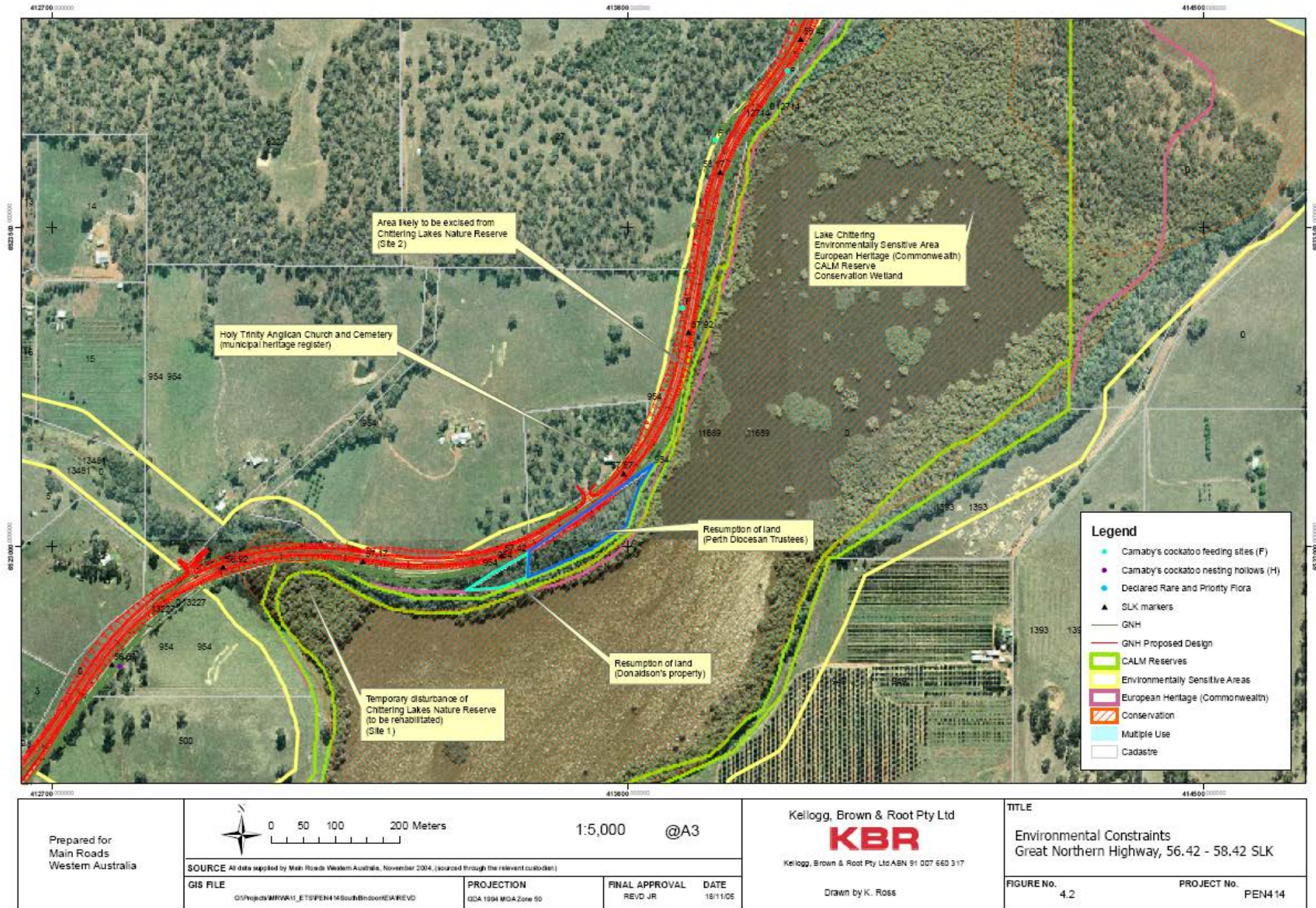
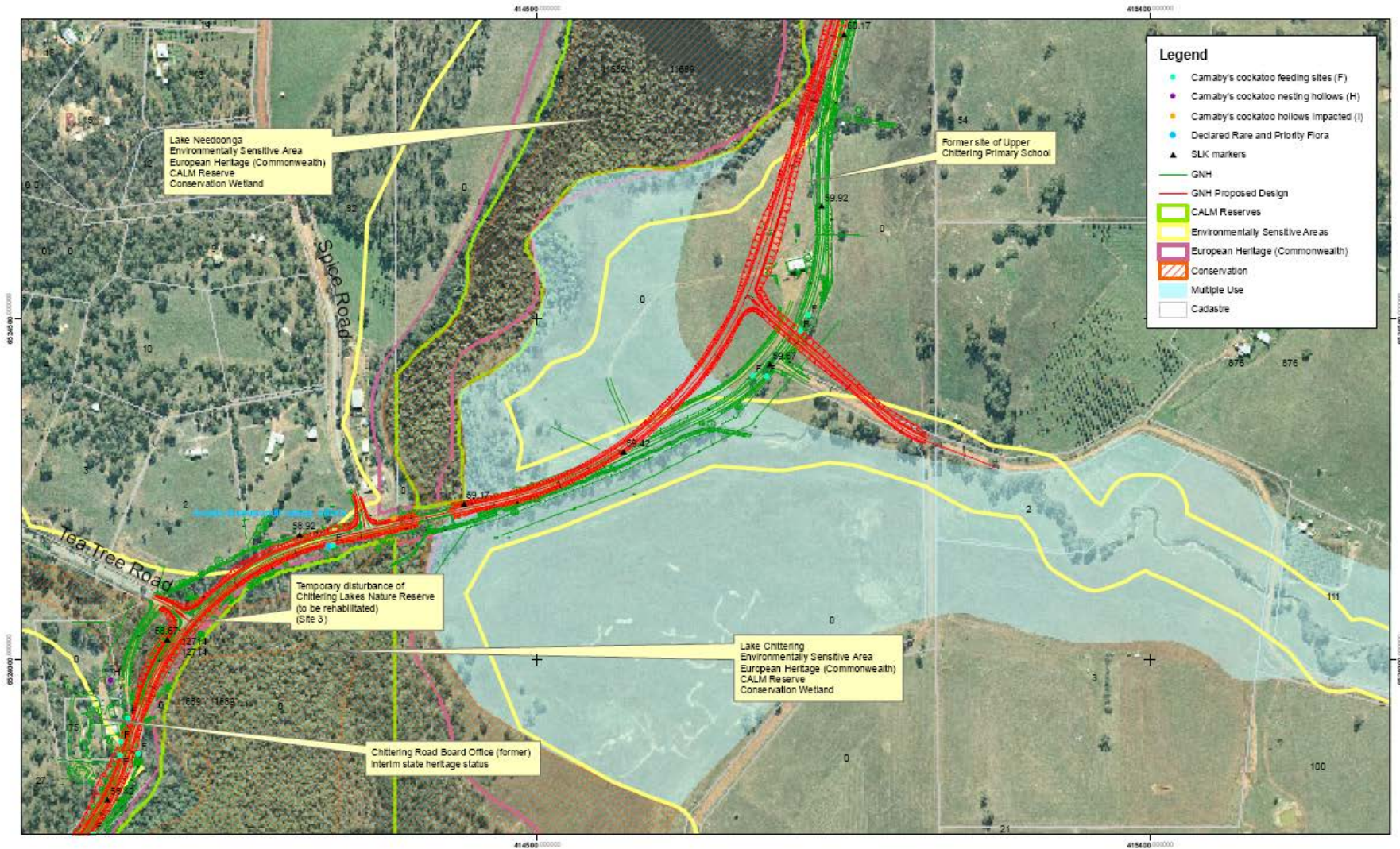


FIGURE 4 AERIAL PHOTOS, 58.4 TO 60.2 SLK



Prepared for Main Roads Western Australia			1:5,000 @A3		Kellogg, Brown & Root Pty Ltd Kellogg, Brown & Root Pty Ltd ABN 91 007 660 317 Drawn by K. Ross	TITLE
	SOURCE All data supplied by Main Roads Western Australia, November 2014. (sourced through the relevant custodian)					Environmental Constraints Great Northern Highway, 58.42 - 60.17 SLK
GIS FILE		PROJECTION	FINAL APPROVAL	DATE	FIGURE No.	PROJECT No.
G:\Projects\MRW\A11_ET5\ENH14\Sub\Bn\Bn\WEA\REVD		GDA 1994 MGA Zone 59	REVD JR	18/11/05	4.3	PEN414

FIGURE 5 AERIAL PHOTOS, 60.2 TO 62.1 SLK

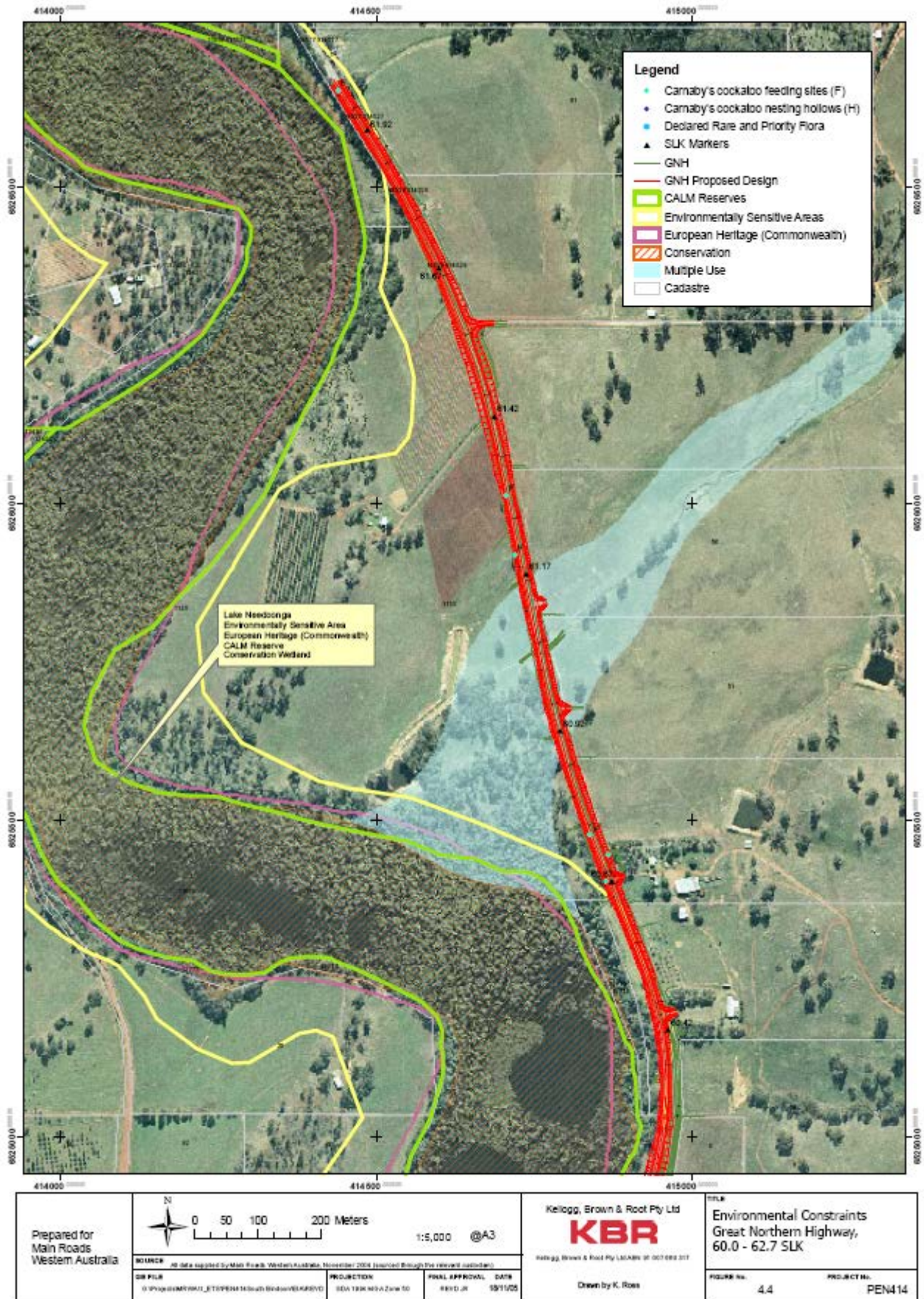


FIGURE 6 AERIAL PHOTO, KAY-PARKINSON PROPERTY ~60.7 SLK



FIGURE 7 AERIAL PHOTO, CLAYTON PROPERTY - 3.5HA LAYDOWN REVEGETATION

