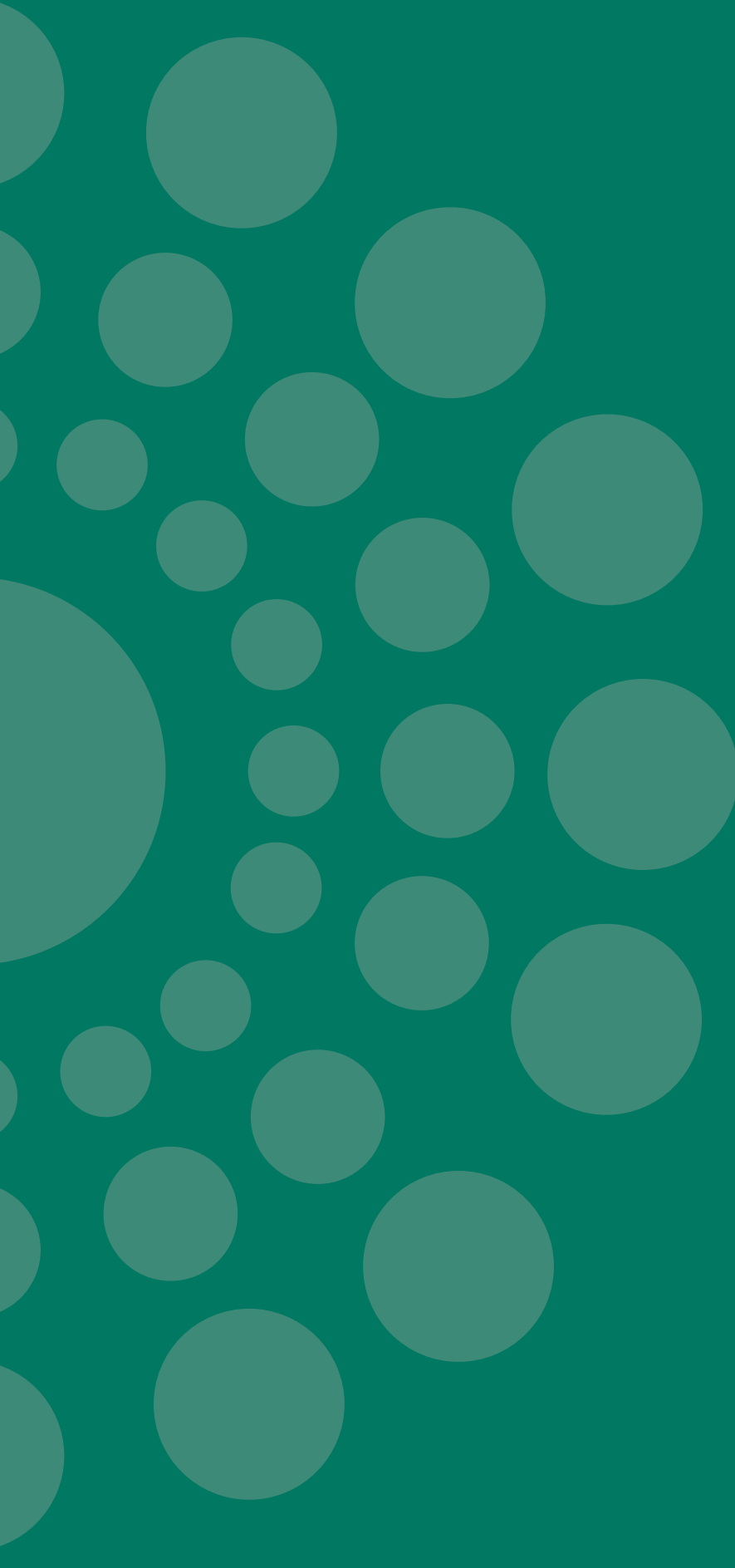


Chapter 3

Existing Environment



3 EXISTING ENVIRONMENT

The purpose of this chapter is to summarise the existing environment within which the project area is situated. There are technical reports that describe some of the topics in this chapter in more detail. These are listed in Table 3-1.

Table 3-1. Appendices relevant to this chapter

Appendix	Report title	Corresponding section in this chapter
H	• Land Capability Assessment	• Soils & Land suitability
G	• Land Suitability Assessment	• Soils & Land suitability
F	• Surface Water Quality Monitoring Report	• Surface water
J	• Aquatic Ecology Report	• Surface water
E	• Groundwater Report	• Geology • Groundwater
I	• Flora and Fauna Assessment Report	• Threatened species & Vegetation communities
K	• Biting Insects Assessment Report	• Biting insects
L M	• Archaeological Survey Report • Aboriginal Areas Protection Authority certificate	• Cultural heritage

3.1 CLIMATE

The climate for the project area is typical of the wet-dry tropics – a dry season from May to September and a wet season from November to March. Figure 3-1 depicts climate data from Middle Point weather station (ID#014041) which, approximately 20 km to the east, is the nearest weather station to the project area.

The bulk of the annual rainfall (averaging ~1400 mm) occurs during the wet season, with negligible rain during May to October. The wettest months are January and February. The average evaporation rate is approximately 2,400 mm per annum (BOM 2015). Temperatures range from a highest average maximum in October to a lowest average minimum in July.

Mean monthly wind speed recorded at Darwin Airport ranges from 8.7 km/h (during November at 9 am) to 20.9 km/h (during September at 3 pm). Wind speeds generally display a higher maximum speed in the dry season months, when prevailing winds are south-easterly associated with high pressure cells in central Australia. During the wet season, monsoonal weather from the north-west is more typical. Throughout the course of a year, wind direction is predominantly east-south-east in the morning and north-west in the afternoon. Cyclonic conditions can occur during the wet season.

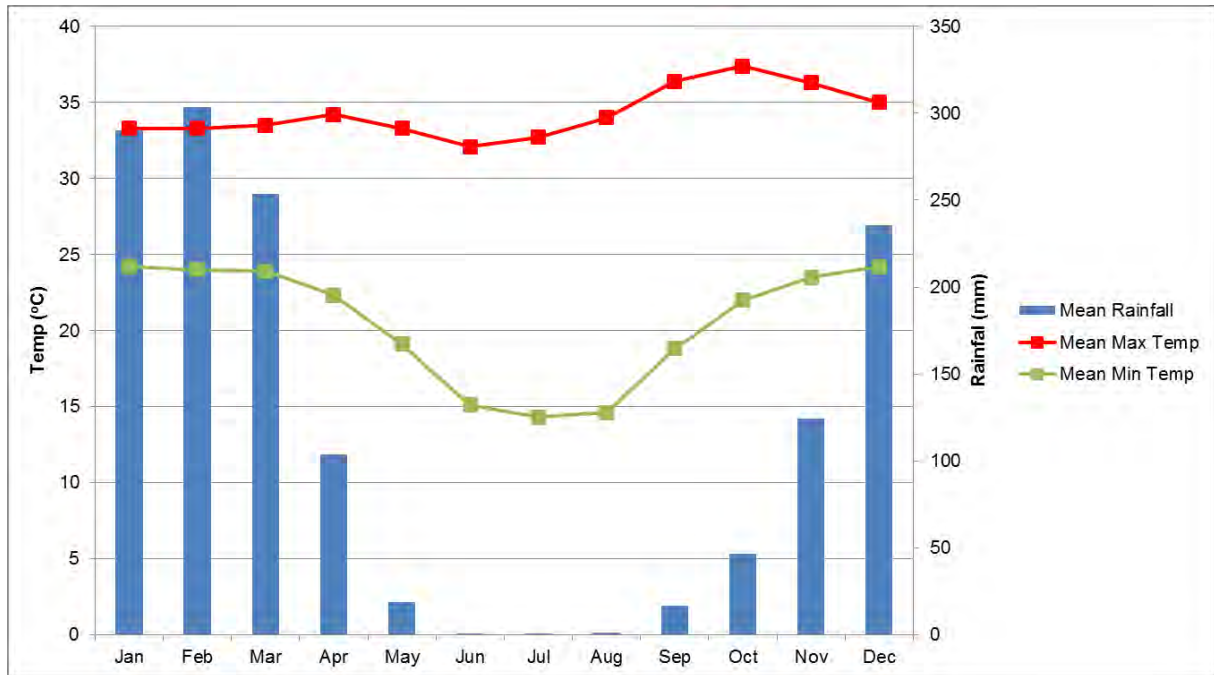


Figure 3-1. Graph of climate data from Middle Point weather station

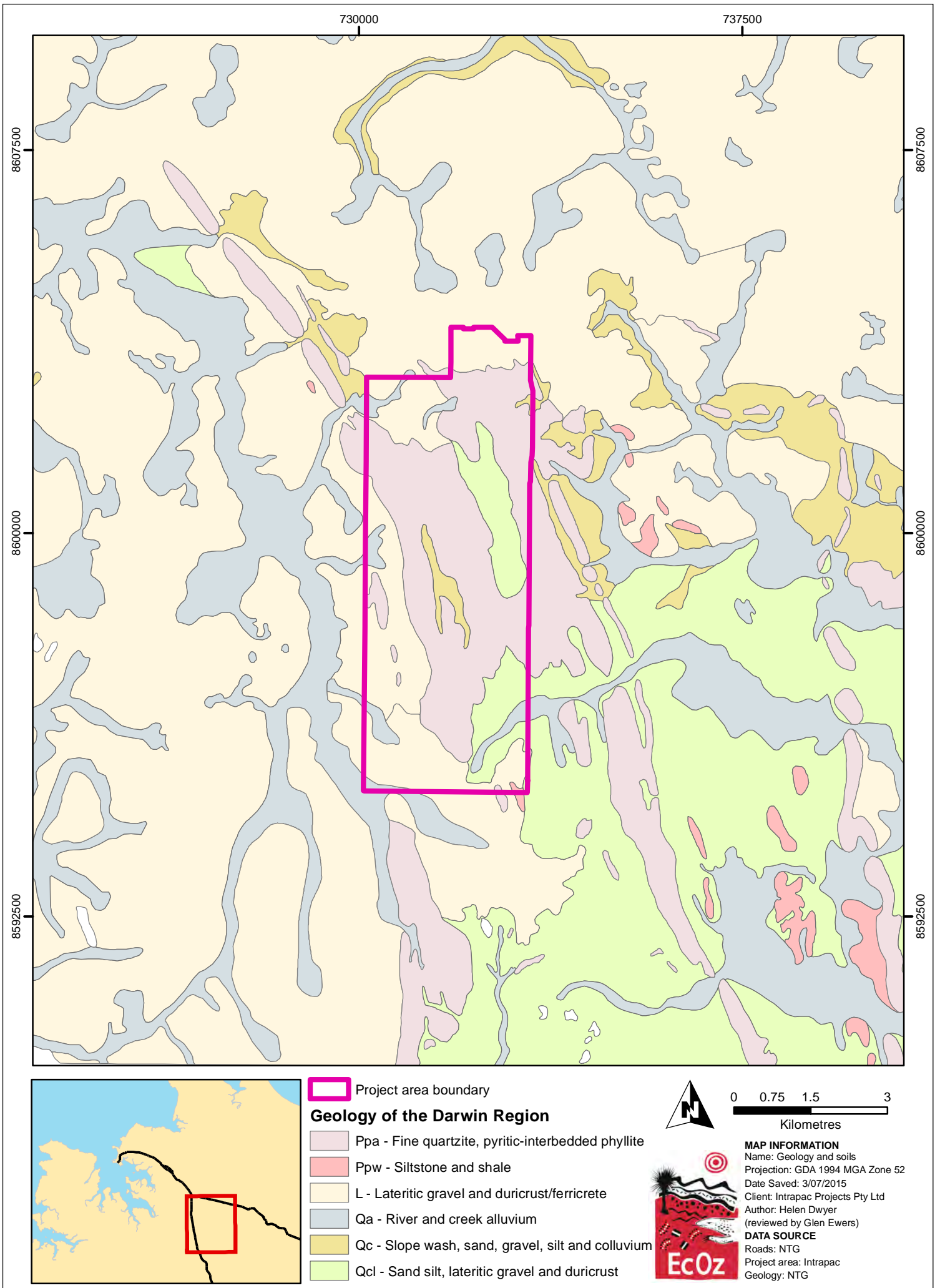
3.2 GEOLOGY

The project area is situated within the Pine Creek Complex, a highly complex geological area. Geological mapping for Darwin undertaken by Doyle (2001) at 1:100,000 scale for the extractive industry is presented in Figure 3-2. The main geological units for the project area are described in Table 3-2.

Table 3-2. Geological units and corresponding descriptions for the project area

Geological units	Description	Landform association
Ppa	Fine to medium Acacia Gap quartzite, pyritic-interbedded phyllite.	Hills and ridges
Qcl	Sand, silt, transported laterite gravel and intact duricrust.	
Qc	Slope wash, sandy flood plains, gravel, sand silt and colluvium.	
L	Laterite gravel (pisolitic and nodular) and duricrust/ferricrete.	Low plains
Ppw	Wildman siltstone and shale, colour-banded and pyritic at depth.	
Qa	River and creek alluvium – gravel, sand, silt.	Drainage areas

The majority of the project area is comprised of geological unit Ppa that characterises the hills and ridges that dominate the centre portion of the site, including rocky out-crops. Discrete areas of geological units Qcl and Qc – characterised by transported materials (sand, silt and gravel) – occur on the side slopes present in the middle and eastern half of the site. Areas characterised by the presence of lateritic gravel occur around the western and northern parts of the site, and river and creek alluvium occurs in association with the drainage lines that intersect the western and eastern site boundaries.



Path: Z:\01 EcoZ_Documents\04 EcoZ Vantage GIS\EZ14400 - Noonamah Ridge Estates EIS\01 Project Files\General Environment Maps_HD\Geology and soils.mxd

Figure 3-2. Map of the geology of the project area and surrounds

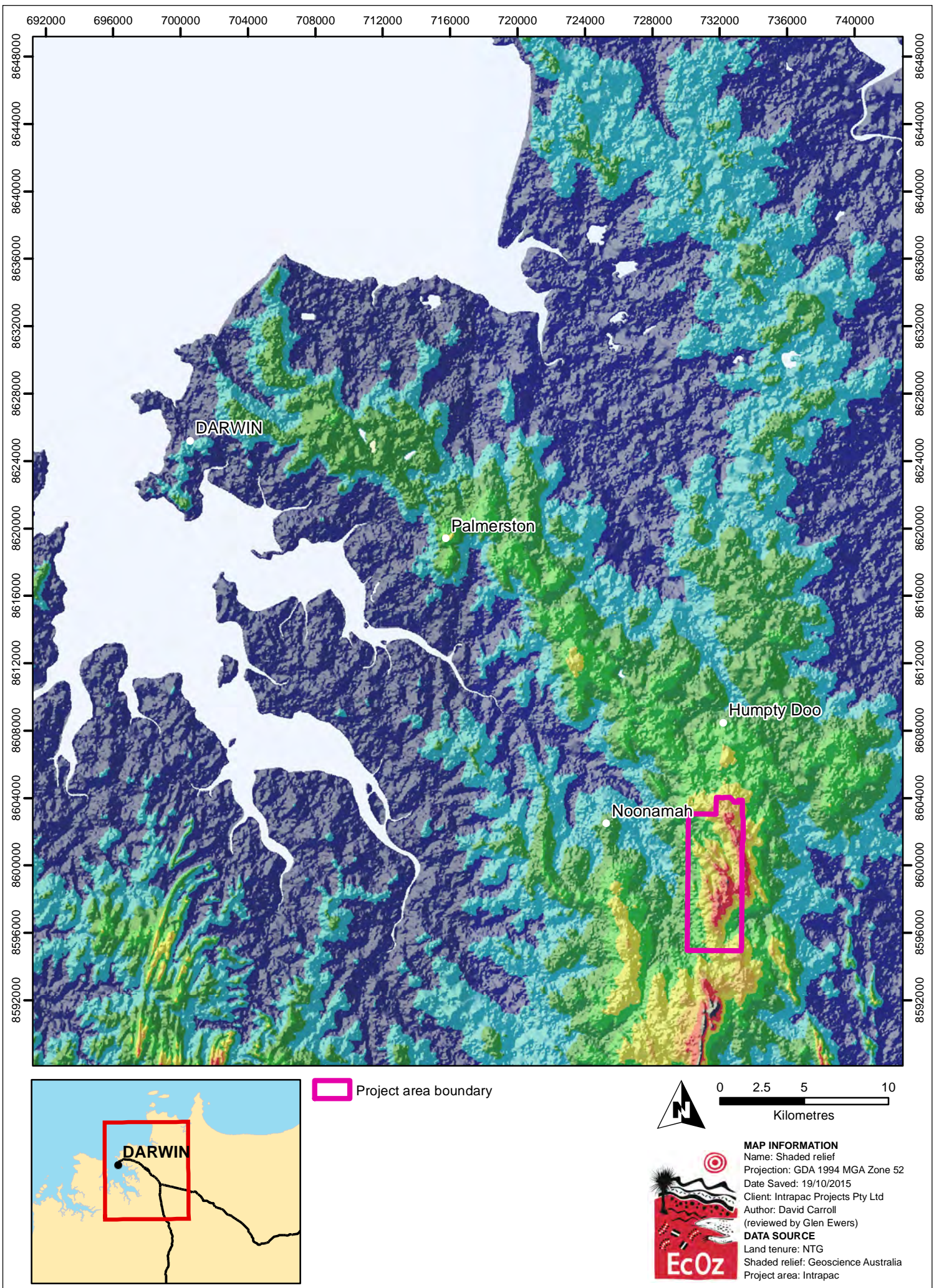
3.3 TOPOGRAPHY

The topography of the Darwin region is dominated by a relatively flat to gently-undulating surface generally less than 30 – 40 m above sea level (see Figure 3-3 and Nott (2003) for more detail). However, the project area is distinct in that it features a substantial series of quartzite and sandstone hilly ridges running diagonally through it on a north-west to south-east alignment. The highest points within the project area are approximately 80 m above sea level and are situated in the south near the telecommunications tower. The lower areas – largely on the eastern and western boundaries of the project area – are approximately 30 m above sea level.

Hilly ridges occupy over 50 % of the project area (see Figure 3-4). These grade into low rises, then to flat, gently-undulating upland areas towards the project area boundaries. Within the hilly areas, some of the steepest slopes are approximately 18 – 20 %. These occur as localised hill slopes up to 110 m in width and 400 m or more in length. The hilly areas feature some broad hill crests (over 350 m in width) with a slope of approximately 5 – 6 %. Generally, the rugged hills exhibit a pattern of undulating rises separated by open drainage depressions, with a slope of up to 20 %.

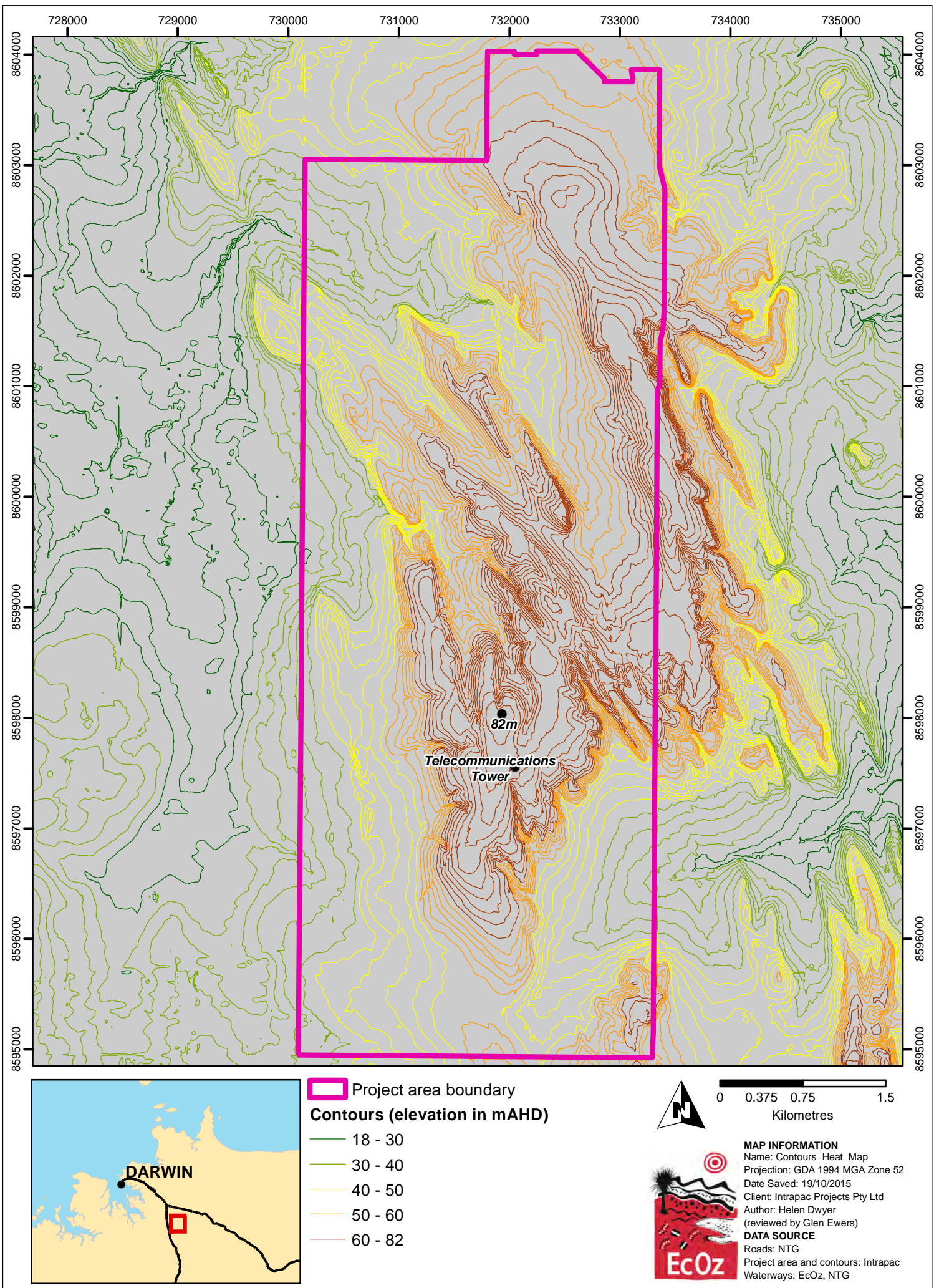
Within the lowlands, the drainage areas are generally broad depressions with occasional incised or gully-like systems.

See Section 3.5 and Appendix G (*Land Suitability Assessment*) for detail as to how topography influences the erosion potential within the project area.



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Figure 3-3. Map of the topography of the greater Darwin region



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Figure 3-4. Map of the contours of the project area and surrounds

3.4 SOILS

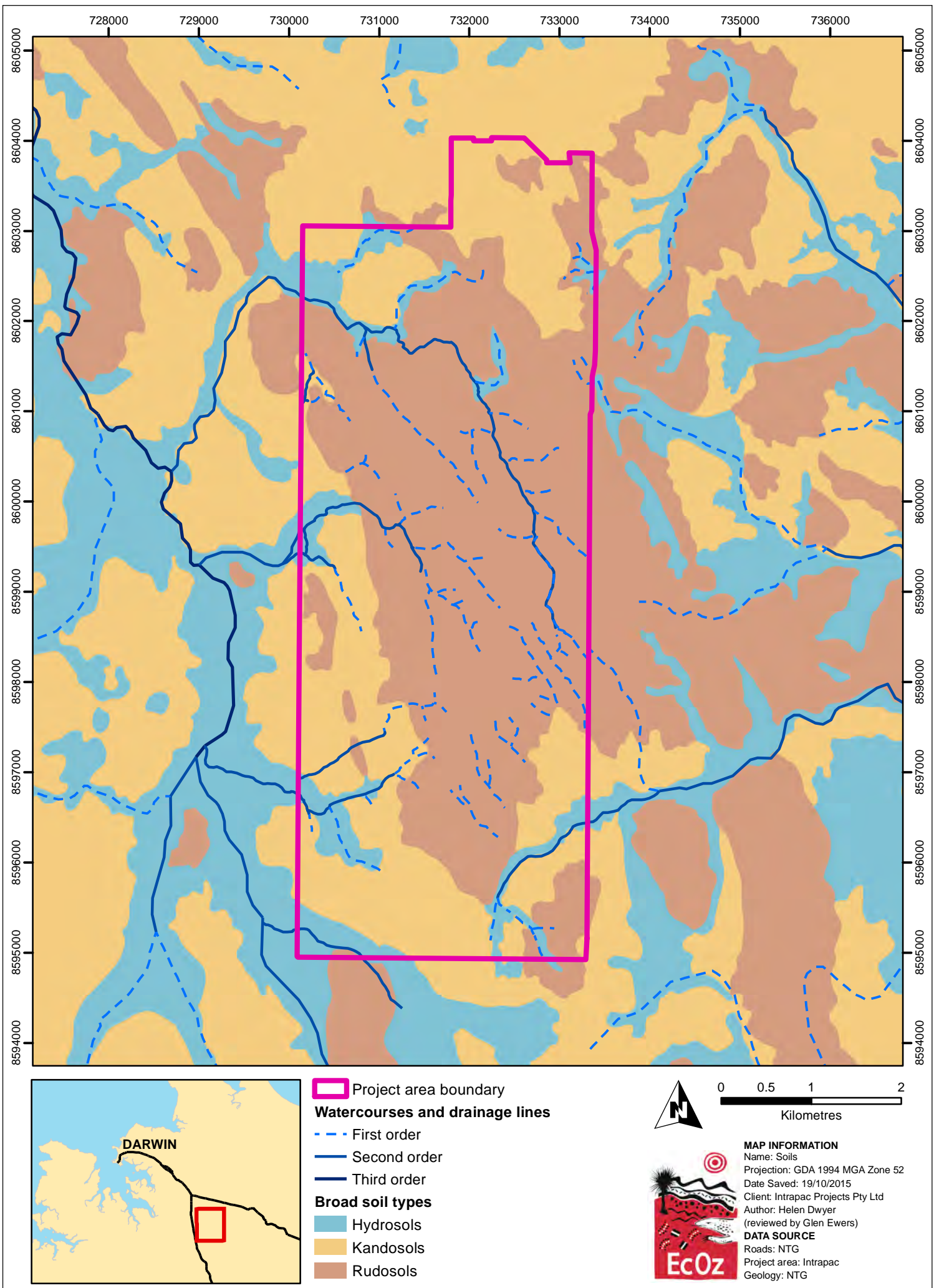
The soil types within the project area comprise a combination of hydrosols, kandosols and rudosols (see Figure 3-5). The general characteristics for these soils types are described in Table 3-3.

Table 3-3. General characteristics of the soils types present within the project area

Soil type	General characteristics*	Association landform
Hydrosols	<ul style="list-style-type: none"> Defined based on seasonal or permanent wetness. The greater part of the profile is saturated for prolonged periods (2 – 3 months) in most years. Site drainage patterns are key factor in defining the extent. 	Low lands associated with drainage
Kandosols	<ul style="list-style-type: none"> Lack a clear textural B horizon. Not calcareous throughout and the clay content of the massive to weakly-structured B2 horizon exceeds 15 % equivalent to heavy sandy loam. Soils can be quite deep up to 3 m or more in depth. The clay content can increase to 35 – 50 % by a depth of 0.5 – 1 m. Clay content is dominated by kaolinite. Red and brown sub-orders are generally permeable and well-drained. 	Level plains and lower slopes
Rudosols	<ul style="list-style-type: none"> Consists of material not greatly affected by pedological processes. Soils feature little pedological development apart from a minimal A1 horizon or presence of a minor B horizon in the fissures of the parent rock. The soils are apedal or only weakly structured in the A1 horizon and show no pedological colour changes apart from the darkening of an A1 horizon. There is little or no texture or colour change with depth unless stratified or buried soils are present. In Northern Australia, these soils types can be shallow gravelly sands formed on siliceous rocks of quartzite or sandstone. 	Hills and rugged slopes

* Descriptions taken from McKenzie et al. (2004)

See Section 3.4, Appendix G (*Land Suitability Assessment*) and Appendix H (*Land Capability Assessment*) for detail as to how soil types influence the drainage, erosion potential and onsite wastewater management within the project area.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ14400 - Noonamah Ridge Estates EIS\01 Project Files\General Environment Maps_HD\Soils.mxd

Figure 3-5. Map of the broad soil types within the project area and surrounds

3.5 LAND SUITABILITY

Land suitability promotes land uses that utilise land for its most suitable economic use while also reducing potential environmental and social risks. It does not necessarily prevent a land use from occurring, but in most situations indicates that additional inputs in terms of costs, design, planning and ongoing management could be required in order to adequately address social, economic and environmental risks.

(Excerpt from the *NT Land Suitability Guidelines*)

A *Land Suitability Assessment (LSA)* is a requirement for all developments that are subject to Clause 11.4.1 (Site Characteristics of Subdivisions of Rural and Unzoned Land) of the *NT Planning Scheme*. The *NT Land Suitability Guidelines* (DLPE 2013) stipulate how to assess rural subdivisions to demonstrate that a proposed development has sufficient unconstrained land to support planned uses. The basis of an LSA is land unit mapping.

A land unit is ‘a reasonably homogenous part of a land surface, distinct from surrounding terrain with consistent properties in landform, soil and vegetation’ (Jessop & King 1997). Mapping these identifies the vegetation types and extents throughout the property, and provides an indication of soil types and drainage.

An LSA was undertaken for the project area (see Appendix G), with land units ground-truthed and refined to a scale of 1:10,000 as required in the EIS Terms of Reference. Fourteen land units occur within the project area (see Figure 3-6). The LSA identified the following site characteristics that may require further consideration throughout the planning, design and construction of the proposed development:

- In general the ridges, side slopes and uplands (land units 1c, 2a1, 2b2, 3a, 3b, 3c and 3d) are rapidly to moderately well-drained – hence categorised as ‘suitable’ with respect to drainage. Lower slope areas (land units 3e, 4b and 4c) are imperfectly drained due to landform and soils, and are categorised as ‘marginally suitable’. Low-lying drainage floors and creek lines (5b1, 6a1, 6a2 and 6b) generally receive stormwater run-off and direct it toward the west and east of the project area. These areas are seasonally waterlogged and/or inundated, and are categorised as ‘not suitable’ for development.
- Areas of slopes > 0.75 % are categorised as ‘marginally suitable’ and slopes > 5 % are categorised as ‘not suitable’ in terms of erosion risk (see Figure 3-7).
- The presence of creeks and drainage lines within the project area indicates that there is a risk of riverine flooding in low-lying areas. Flood mapping is not available for the project area, but modelling has been undertaken for the main drainage system within the site, presenting the 1 % AEP (1 in 100 years) flood line. Further modelling is required to identify other areas within the project area below the 1 % AEP line. Such areas may be considered unsuitable for development and mitigation measures will be required.
- Soil salinity, acid sulfate soils and storm tide flooding are not considered a risk due to the location and characteristics of the site, and therefore the entirety of the project area is categorised as ‘highly suitable’ (S1) in terms of these assessment categories.

In addition to slope, the two other key features of the project area that will influence erosion are:

- **Soil:** Generally, soils with higher silt and/or clay content have greater erosivity (compared to sandy or loamy soils). Detailed soil analysis has not been undertaken for most of the site.
- **Exposure:** Surface cover, either in the form of vegetation or gravel reduces the exposure of soils to erosive forces such as wind and rain. Removal of natural cover during land clearing will therefore increase the risk of erosion throughout the project area.

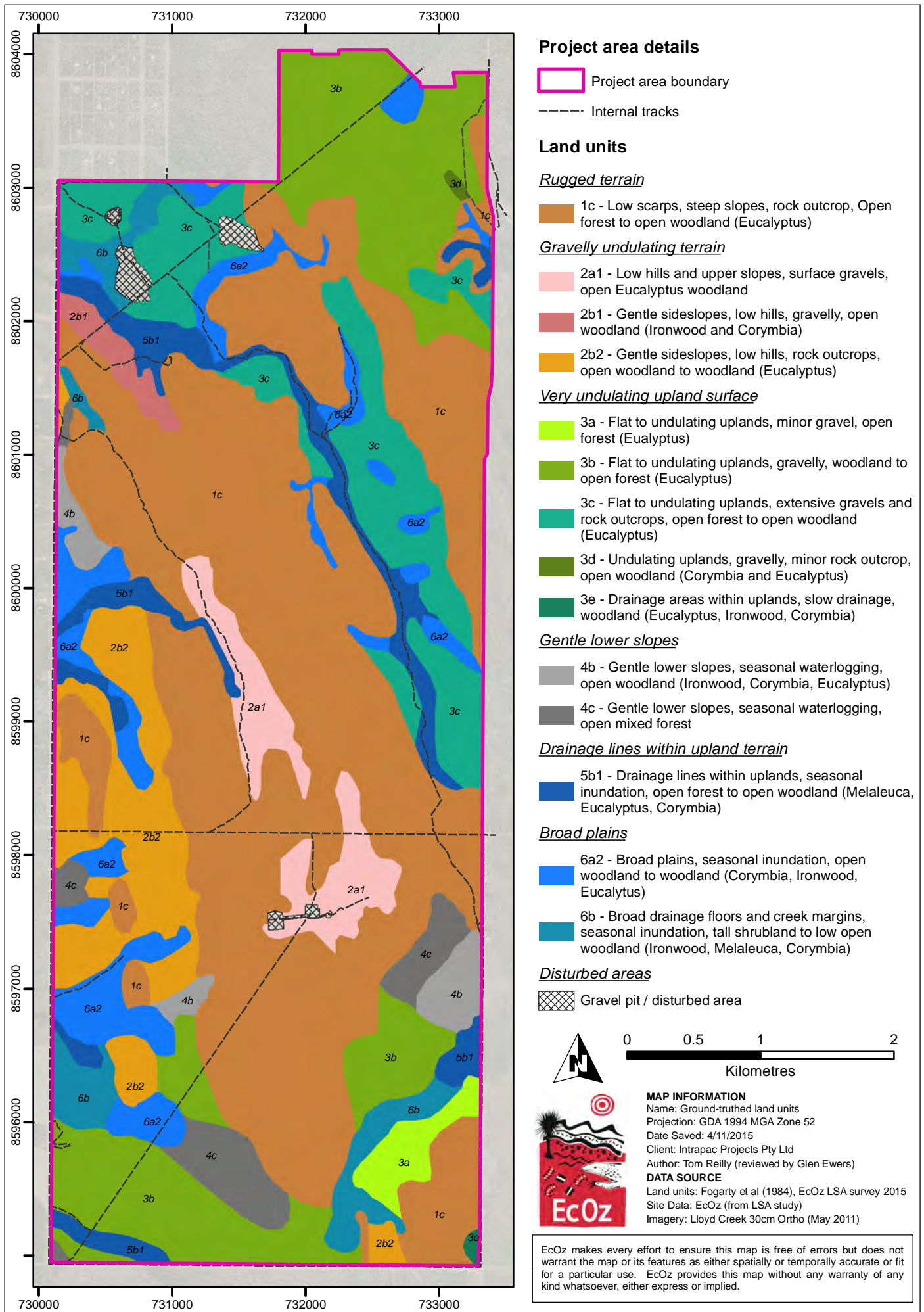


Figure 3-6. Map of the ground-truthed land units within the project area

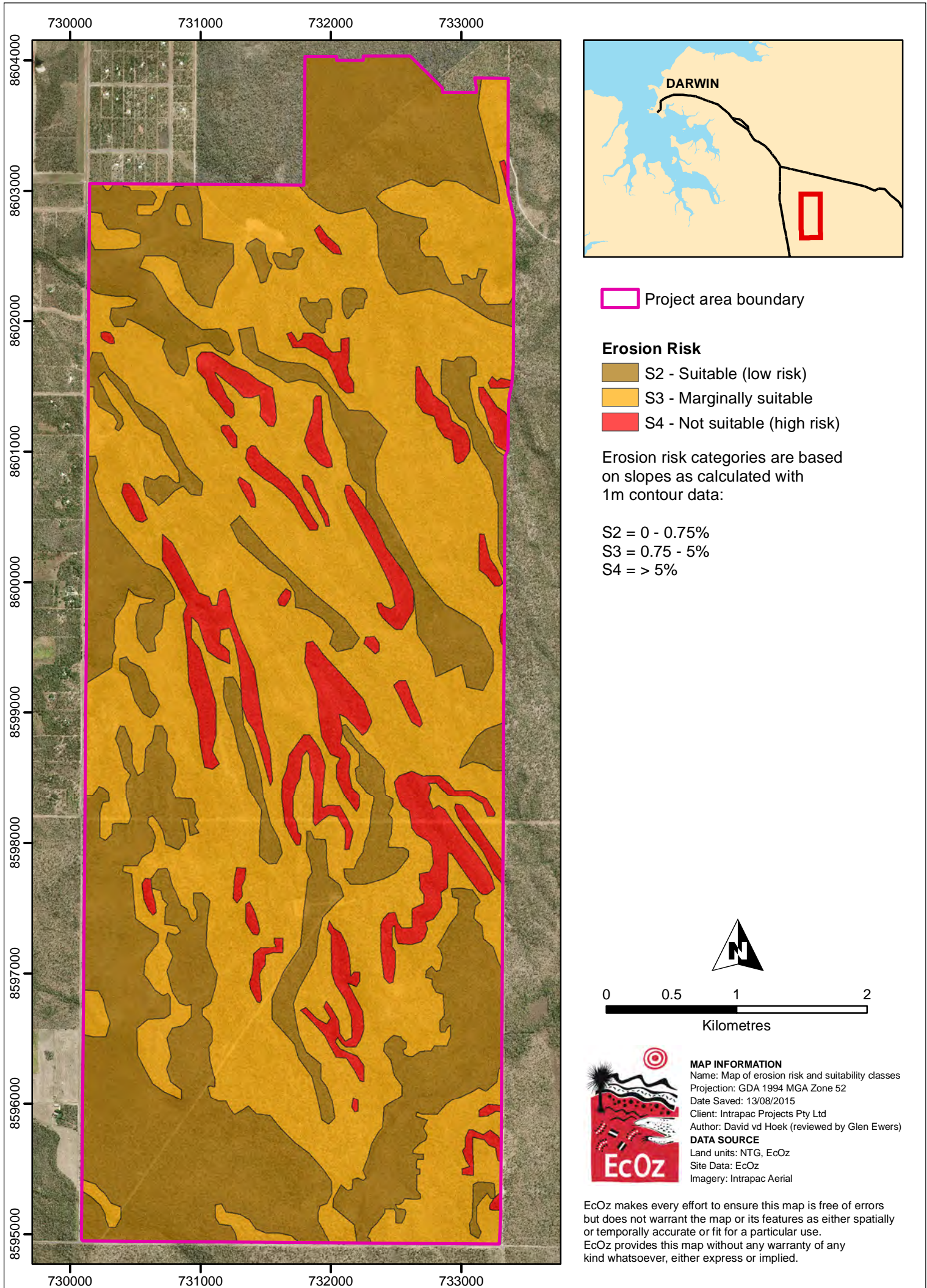


Figure 3-7. Map of erosion risk within the project area

3.6 WATER

3.6.1 Surface water

Local and regional catchment context

The project area lies within two surface water catchments, as mapped by the National Geochemical Survey of Australia (NGSA 2011). The majority of the project area (63 %) is in the upper Elizabeth River catchment, a major tributary of the Darwin Harbour catchment, with the remaining eastern section draining into the Adelaide River catchment (see Figure 3-8). The project area encompasses approximately 22 % of the upper Elizabeth River catchment, as defined by the area of the catchment upstream of the Stuart Highway.

Catchment hydrology

Drainage within the project area can be summarised as narrow, rapidly-draining seasonal gullies and upland drainage lines (first order) in the ridges and upper slopes, which capture and divert run-off toward the broad drainage floors and seasonal creek lines (second order) in the lowlands (see Figure 3-9). Some upland gullies end in overland flow and hence are non-continuous drainage lines. Broad seasonally-inundated drainage floors exist within poorly-drained areas; many of these do not have distinct drainage lines within them.

There are ten sub-catchments within the project area, draining either west into the Elizabeth River or east toward the Adelaide River (see Figure 3-8). The largest sub-catchment in the project area (Sub-catchment D) traverses the project area from south-east to north-west, discharging along the northern section of the western boundary. Preliminary calculations of peak flow rates have been made for a Q5, Q20 and Q100 (i.e. a one-in-five year etc.) flood event for each catchment within the project area (see Table 3-4 and, for further detail, Section 2.9.3).

Table 3-4. Peak flow rates per catchment (m³/s)

Catchment	Q5	Q20	Q100
A	6	8	15
B	13	15	30
C	25	28	57
D	155	175	311
E	82	92	154
F	80	90	170
G	81	91	161
H	1	1	3
I	13	15	29
J	2	2	4

The Elizabeth River is an intermittent system that flows during the wet season and usually ceases to flow by June/July each year, with occasional permanent pools. The tributaries of Elizabeth River that flow from the project area are ephemeral, flowing only during the wet season, ceasing to flow early in the dry season (i.e. March/April) and drying completely in the following months. Other than the drainage lines and associated seasonally-inundated areas, there are no major wetlands within the project area.

During the community consultation sessions held for this development, a number of residents of properties to the west of Redcliffe Road indicated that since roadworks and drainage easement works were undertaken on Redcliffe Road approximately seven years ago, their properties have experienced seasonal flooding.

The land areas within the project area that may be susceptible to flooding are limited by the relatively steep topography and rapid-draining upland areas. Modelling of the 1 % AEP has been prepared for the largest catchment within the project area (Sub-catchment D) indicating that flooding may occur within 50 – 100 m of drainage lines (see Figure 3-9).

Existing users and beneficial uses

There are no known downstream consumptive users of surface water (i.e. extraction for water supply) that originates from the project area, but there are likely to be significant recreational (e.g. fishing) and aesthetic values held by both the general public and local land-owners along the Elizabeth River and its tributaries.

The western section of the project area is located within the Elizabeth River catchment (i.e. Darwin Harbour Catchment), which states the following in relation to surface water declared for the Darwin Harbour Region under the *Water Act*:

- *The protection of environment, cultural (aesthetic, recreational and cultural), agriculture and rural stock and domestic to be the beneficial uses of water that apply to all natural waterways in the Darwin Harbour catchment, including all named and unnamed springs, creeks, rivers, lakes, lagoons, swamps or marshes.*

The project area is also located within the Darwin Rural Area Water Control District. Water Control Districts are declared in areas where it is recognised that increasing development and demand for water have the potential to cause degradation to water quality and to reduce flows required to maintain water-dependent ecosystems in the region.

Surface water quality

A detailed review of available surface water quality data from previous monitoring and a targeted baseline monitoring program undertaken in relation to the project area over the 2014/15 wet season is provided in Appendix F. Long term water quality monitoring undertaken by the NT Government in the Elizabeth River downstream of the project area, indicates that some pollutants (mainly nutrients and suspended sediments) are often slightly elevated above Darwin Harbour Water Quality Objectives. Despite this, ongoing monitoring and reporting of the water quality of Elizabeth River by the NT Government for the *Darwin Harbour Report Cards* has consistently assigned the water quality an “A” condition rating (‘excellent water quality’) from 2010 – 2014 (DLRM 2014).

The existing quality of water within the project area is generally very good, with low turbidity and low concentrations of suspended solids, dissolved ions and heavy metals. Concentrations of nutrients are occasionally slightly above guideline values at some locations – with most of these being observed at sites downstream of the project area that receive run-off from existing rural and agricultural developments in other areas of the catchment, or else being due to seasonal effects (i.e. periods of no flow and associated evapo-concentration).

Aquatic ecology

The project area comprises drainage lines and seasonally-inundated areas that may be sensitive to changes in hydrology and water quality. Targeted biodiversity surveys conducted in the project area identified several threatened flora and fauna species that reside in drainage lines and/or seasonally-inundated areas. These are Spiderflower (*Cleome insolata*), *Typhonium praetermissum* and *Utricularia hamiltonii* (flora) and Howard River Toadlet (*Uperoleia daviesae*), Mertens’ Water Monitor (*Varanus mertensi*) and Black-footed Tree-rat (*Mesembriomys gouldii*) (fauna). Further details of the conservation significance of these species and their distribution within the project area are provided in Section 3.9 and Appendix I.

A review of previous aquatic ecology monitoring undertaken in the Elizabeth River catchment and the results of a targeted baseline macro-invertebrate survey are provided in Appendix J. Sampling of macro-invertebrates was undertaken at three sites at the boundary of the project area and downstream in April 2015, in accordance with established AUSRIVAS macro-invertebrate monitoring protocols (Lamche 2007).

Macro-invertebrate data were analysed using the Darwin-Daly genus-level AUSRIVAS model, with the two sites at the boundary of the project area having lower than expected taxonomic richness and the downstream Elizabeth River site being similar to the reference condition (as assessed in previous NT Government monitoring). As the water quality in streams draining the project area is considered very good and there is no current development within their respective sub-catchments, the relatively poor macro-invertebrate community health may be attributable to naturally-poor habitat availability for macro-invertebrate colonisation and/or hydrological conditions associated with their location high in the catchment.

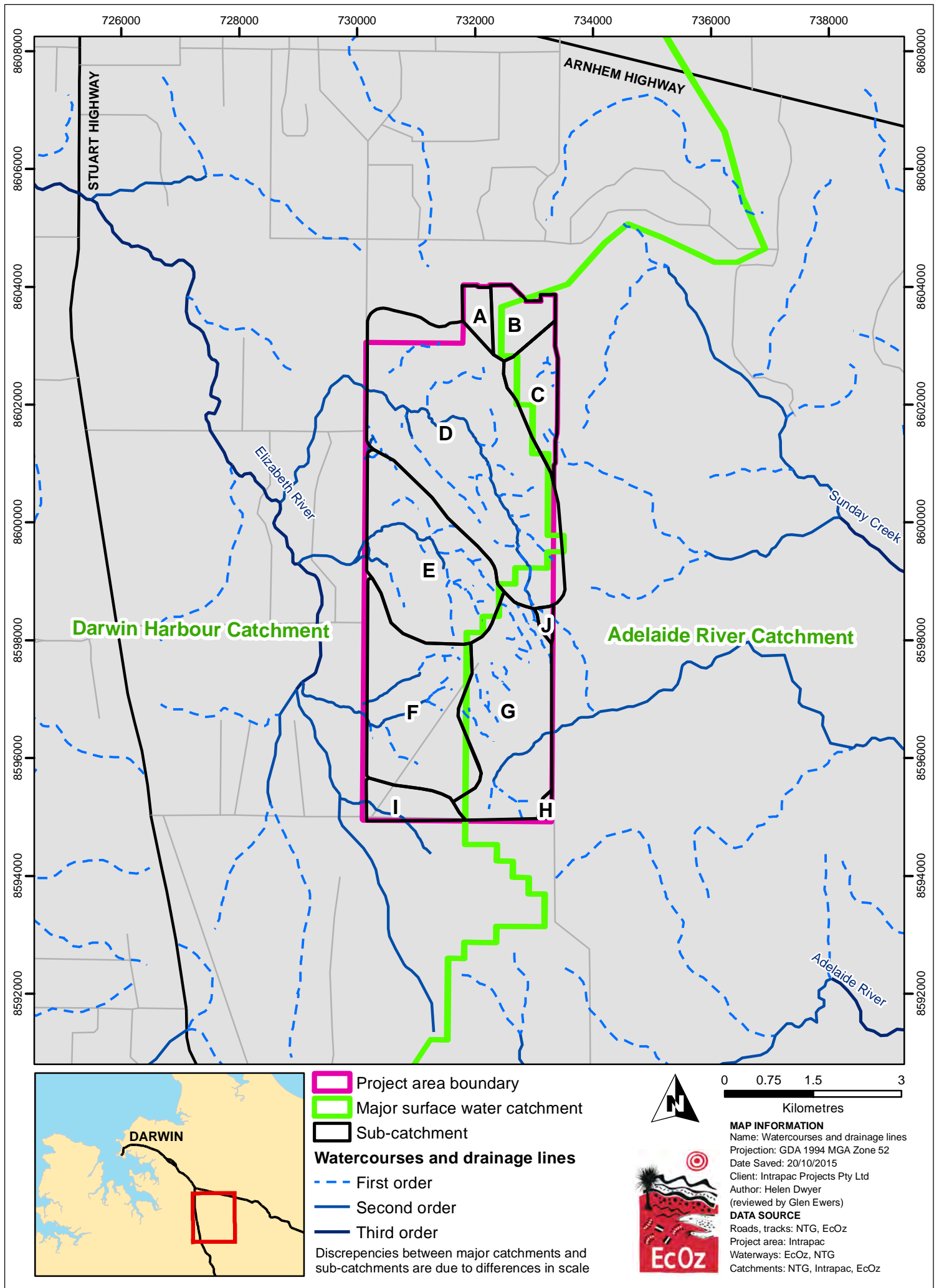
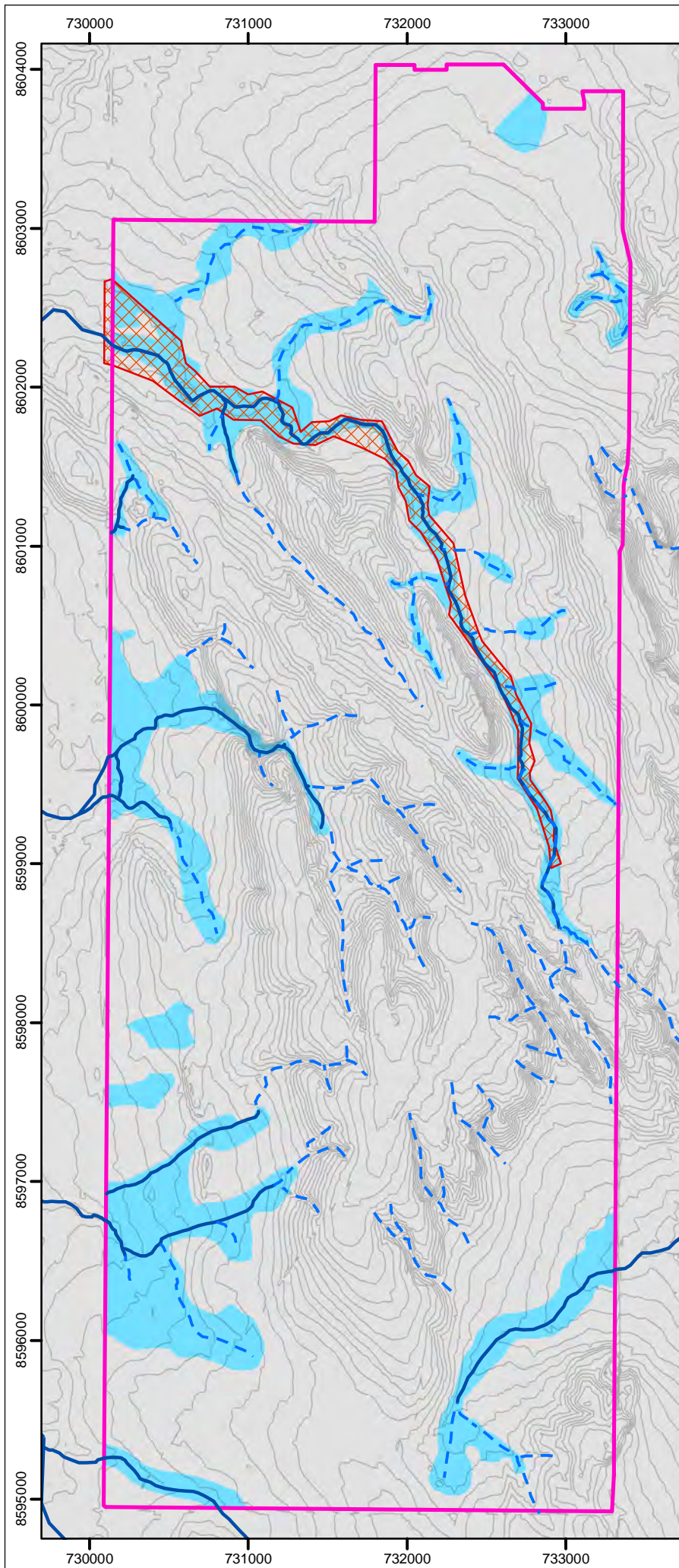


Figure 3-8. Map of the drainage lines and watercourses within project area and surrounds



- Project area boundary
- 1 % AEP riverine flood modelling
- Seasonally-inundated areas

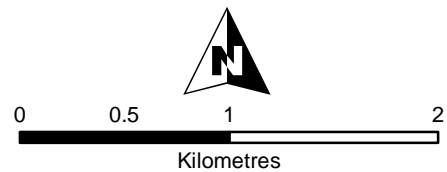
Watercourses and drainage lines

- First order
- Second order

First order drainage lines include seasonal drainages and gullies in uplands. Some upland gullies end in overland flow, and hence are non-continuous drainage lines.

Second order drainage lines are seasonal creek lines.

Broad drainage floors exist within poorly-drained areas and may not have distinct drainage lines within them.



MAP INFORMATION

Name: Drainage and 1in100yearFlood
 Projection: GDA 1994 MGA Zone 52
 Date Saved: 19/10/2015
 Client: Intrapac Projects Pty Ltd
 Author: David Carroll (reviewed by Glen Ewers)

DATA SOURCE

Land units: EcOz
 Flood modelling: Byrne Design
 Waterways: EcOz

EcOz makes every effort to ensure this map is free of errors but does not warrant the map or its features as either spatially or temporally accurate or fit for a particular use. EcOz provides this map without any warranty of any kind whatsoever, either express or implied.

Figure 3-9. Map of ground-truthed surface water and available 1 % AEP riverine flood modelling within the project area

3.6.2 Groundwater

Regional aquifers

The project area is situated within a complex geological area that results in a variable hydro-geology. This is illustrated in Figure 3-11, which shows a significant variability in yields from bores in the existing rural developments surrounding the project area.

To the north-east of the project area lies an extensive aquifer system – commonly known as the ‘Koolpinyah Aquifer’ – that is hosted in overlying sands, gravels, caverns and pores of the Koolpinyah Dolostone. This broad-scale aquifer is shown in Figure 3-10 and is approximately 4 km from the project area at its closest point. Where fractures and/or karstic features have developed in the dolostone, there are good prospects for high-yielding aquifers. However, there has been an apparent overuse of the Koolpinyah Aquifer in some areas, as observed in regional groundwater level monitoring records, and reduced seasonal flows in surface water and springs in the nearby Howard River catchment (Fell-Smith and Sumner 2011).

Existing users and beneficial uses

There are numerous users of groundwater – both domestic and commercial – in the existing rural subdivisions west and north of the project area (as evidenced in the map of surrounding bores presented in Figure 3-11).

The entire project area is also located within the Elizabeth and Howard Rivers Groundwater Declared Beneficial Use Area, which has the following beneficial use in relation to groundwater under the *Water Act*:

The protection of environment, agriculture, public water supply and rural stock and domestic are the beneficial uses that apply to all groundwater within the boundary.

Local aquifers

A groundwater study was undertaken in May – June 2015 to establish a baseline dataset with which to characterise the hydro-geology of the site (Appendix E). The study included a review of available literature, information from neighbouring bores and the drilling of six new investigation bores in selected locations across the site (see Figure 3-12). The investigation indicated that at least three types of aquifer underlie the project area – with at least one porous, high-yielding sandstone aquifer occurring adjacent to a major fault zone.

A summary of the seven aquifer ‘zones’ within the project area is presented in Table 3-5 and Figure 3-12. It highlights that groundwater conditions are highly variable. The low salinity of the groundwater within the project area is typical of seasonally-recharged aquifers in this region and indicates that most areas are actively recharged. Recharge mechanisms are likely to be a combination of direct (rainfall infiltration over a large area) and indirect (rainfall infiltration via surface depressions) inputs, depending on geology. In the lower-lying areas, the common occurrence of saprolitic clays in the upper formations would impede direct recharge, suggesting that indirect recharge is the active mechanism in these areas. Probable sites of enhanced recharge include the steeply-dipping fractured quartzite ridges, and associated colluvial deposits and other structural features.

Due to the steeply dipping and folded beds, and major interruptions by fault lines, yields are variable (0.5 – 15 L/s) from localised aquifers which may extend offsite in some locations. The highest yields observed in drilled bores are zones where fracturing is well-developed – mostly in siltstones and shales, but also sandstones in some cases.

The depths at which the bores drilled within the project area first encountered water was greater than 25 metres below ground level, except in the south-west where there was a modest flow of probably ephemeral groundwater.

The interpretation of groundwater flow directions shown in Figure 3-12 was based on topography, standing water levels and the structural geology. Groundwater flow directions generally appear to radiate from the project area to surrounding areas.

Table 3-5. Summary of information on project area aquifers

Zone	Yield (L/s)	Inferred recharge potential	Groundwater prospects
1	< 3	Low – Moderate	Fractured aquifers, generally limited permeability, limited groundwater supplies. Bore drilling should target fractures.
2	< 0.5	Moderate – High	Fractured, localised aquifers. Good supplies could be found here where fracturing is well developed.
3	Unknown	Low	Fractured, localised aquifers. Good supplies could be found here where fracturing is well developed.
4	~ 12 - 15	Unknown	High yields may be obtained in fractures and sandstone aquifers adjacent to the Noonamah fault.
5	Unknown	Unknown	Similar to Zone 4 by inference, but no bores drilled.
6	11	Low – Moderate	Good aquifers in fractured and weathered siltstones and shales, and possibly limited porous sandstone aquifers. Considerable saprolite clays developed above aquifers, which may reduce direct recharge.
7	Unknown	Low – Moderate	Likely good aquifers in fractured and weathered siltstones and shales. Considerable saprolite developed above aquifers, which may reduce direct recharge.

The results of initial testing of the six bores drilled within the project area show that all groundwater samples meet the *Australian Drinking Water Guidelines* (NHMRC 2011). Water quality shows little variation across the site, with concentrations of dissolved ions being relatively low compared to neighbouring bores west of the project area (implying superior water quality).

Local ground-surface water interaction

Two potential groundwater-dependent ecosystems have been identified on, and adjacent to, the project area. Their locations are shown in Figure 3-12.

The spring-like feature offsite at the south-east corner is probably the result of the intersection of two fault lines, one of which is coincident with the Noonamah fault line and a drainage line at this location. This is the location of a sacred site (see Section 3.14.1).

Another possibly permanent waterbody was observed in the central-eastern section of the site within a drainage line. The underlying clay beds observed during bore drilling in this area suggest that this feature is likely to be a perched soak – rather than spring-fed – although further study would be required to definitively establish whether there is a connection to the aquifer below. The ecological significance of this feature is discussed in Section 3.6.2.

Although difficult to quantify, it is likely that surface water flows during the wet season contribute to aquifer recharge within the project area, particularly when drainage lines intersect the enhanced recharge zones described above (e.g. fractured areas such as the Noonamah Fault).

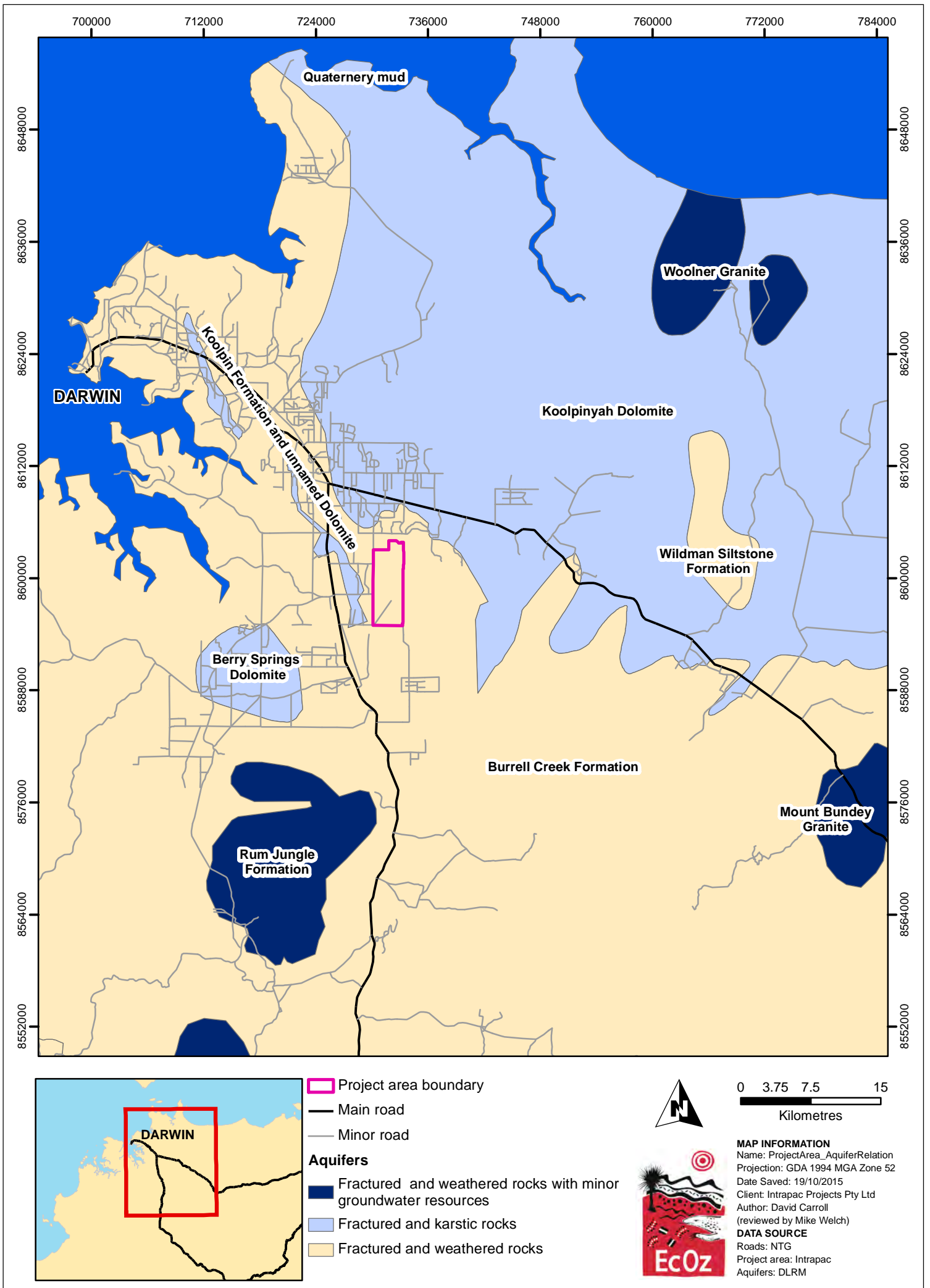
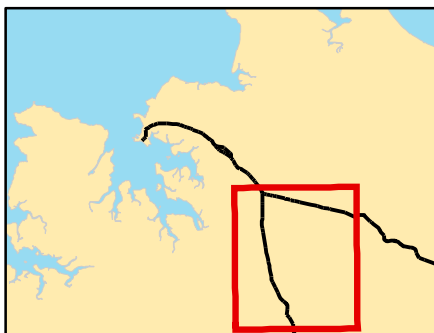
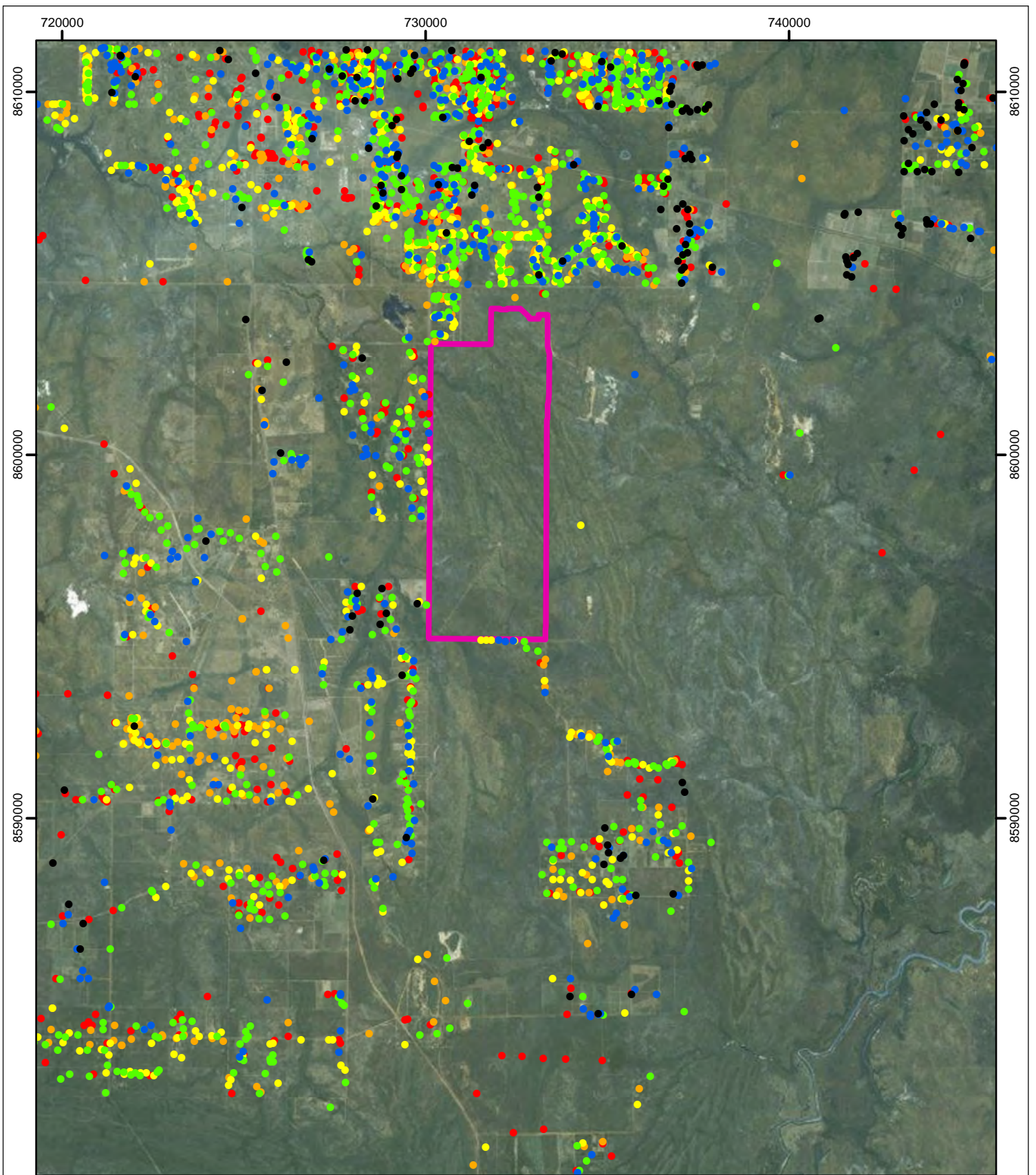







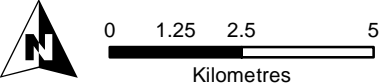


Figure 3-10. Map showing the project area within the regional aquifer context



 Project area boundary
Bore yield (litres per second)


-  0
-  0.0 - 1.0
-  1.0 - 2.0
-  2.0 - 5.0
-  5.0 - 10.0
-  Over 10



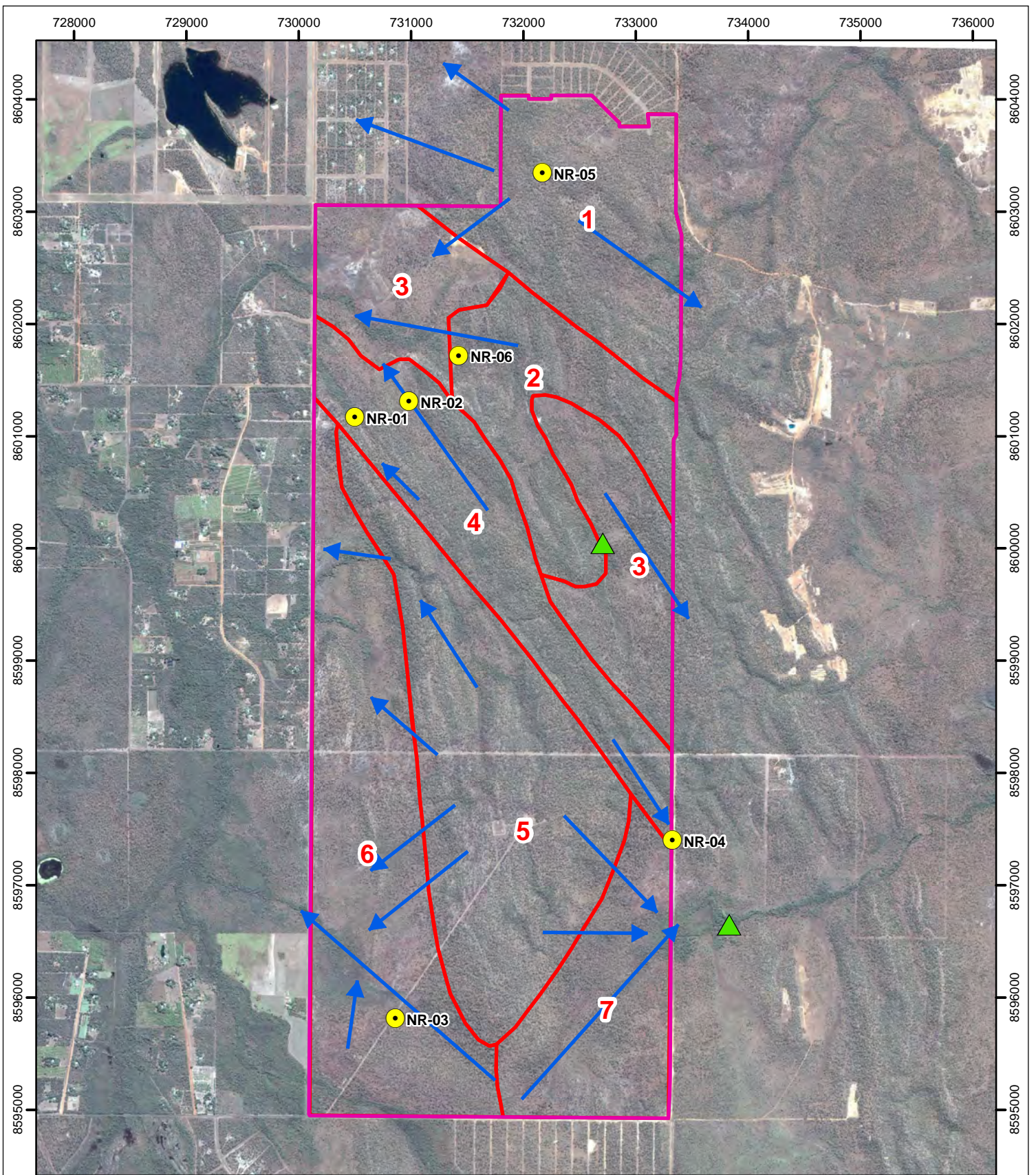
0 1.25 2.5 5
Kilometres

MAP INFORMATION
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 Date Saved: 19/10/2015
 Client: Intrapac Projects Pty Ltd
 Author: D Carroll (reviewed by G.Ewers)

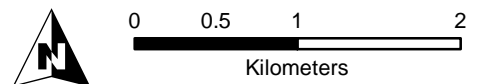
DATA SOURCE
 Bores: NTG
 Project boundary: Client
 Imagery: Esri Basemap



Figur 3-11. Map showing the location of existing groundwater bores in the project area vicinity



- Project area boundary
- Project area bores
- ▲ Potential GDEs
- ➔ Projected groundwater flow direction
- Groundwater zones boundaries



MAP INFORMATION
 Name: GroundWaterZone
 Projection: GDA 1994 MGA Zone 52
 Date Saved: 19/10/2015
 Client: Intrapac Projects Pty Ltd
 Author: David Carroll
 (reviewed by Glen Ewers)
DATA SOURCE
 Roads: NTG
 Project area and contours: Intrapac
 Waterways: EcOz, NTG

Figure 3-12. Map of the groundwater characteristics within the project area

3.7 BIODIVERSITY

Comprehensive wet and dry season flora and fauna surveys were undertaken across the project area in 2014 – 15. The objectives of the survey were to:

- Describe and map vegetation communities
- Identify and assess the conservation significance of sensitive vegetation types
- Identify weed infestations
- Determine the likelihood of the presence of threatened flora and fauna species
- Assess the conservation significance of populations of threatened flora and fauna species
- Describe existing threatening processes.

The full survey report is in Appendix I.

3.7.1 Summary

Flora surveys within the project area recorded 196 species – including three species listed as Vulnerable and one listed as Near Threatened under the *TPWC Act* (see Section 3.9.2). No *EPBC*-listed species were identified.

A total of 127 fauna species was recorded during the surveys – 16 amphibians, 29 reptiles, 65 birds and 17 mammals. Of these, four are threatened species under the *EPBC Act* and/or *TPWC Act* (see Section 3.9.3). Three other species listed as Near Threatened were recorded within the project area – Bush Stone-curlew (*Burhinus grallarius*), Northern Brown Bandicoot (*Isodon macrourus*) and Common Brushtail Possum (*Trichosurus vulpecula arnhemensis*). These species are likely to be fairly common within the project area, as they are bushland, native parkland and even parks in urbanised areas throughout the region. For these reasons, the populations of these three species within the project area are not considered to be of conservation significance.

The habitats found within the project area – predominately Eucalyptus woodland – are common across the Top End. Moreover, the project area sits to the south and east of areas either already developed or that have had substantially modified habitat. Consequently, there are no significant wildlife corridors *per se* within the project area apart from the strips of riparian vegetation mentioned above which form the initial sections of that habitat type which extends to the west.

3.7.2 Existing threatening processes

Feral species

Six feral species (introduced fauna) were recorded within the project area:

- **Cane Toad (*Rhinella marina*)**

This species is listed as a ‘key threatening process’ under the *EPBC Act* because it is lethal to most native animals if consumed. Cane Toads were first detected in the greater Darwin region in 2004 – 5 and have now established significant populations (D. Trembath pers. comm.). In the NT they are known to be a key factor in the decline of a number of native fauna – including Northern Quoll (*Dasyurus hallucatus*) (Oakwood 2003), Monitors/Goannas (*Varanus* sp.) (Doody et al. 2009), and Mulga Snake (*Pseudechis australis*) (D. Trembath pers. comm.). Cane Toads were common and widespread across the site.

- **Feral Cat (*Felis catus*)**

This species is considered a ‘key threatened process’ under the *EPBC Act*. It occurs throughout the Australian mainland in a variety of different habitats including deserts, forests and grasslands. Feral Cats are predominantly solitary, nocturnal, and carnivorous, and can survive with limited access to water, relying upon moisture from their prey. Each cat is estimated to kill between 5 – 30

native species per day (AWC 2012). Cats play a significant role in the decline of native fauna and have been recognised as contributing to the decline of several ground-nesting birds and small to medium-sized mammals. It is assumed that this species is common and widespread across the site.

- **Feral Pig (*Sus scrofa*)**

This species is considered a 'key threatening process' under the *EPBC Act* due to predation, habitat degradation, competition, and disease transmission. Populations are widespread across the Top End and are typically focused around areas of inundation. It is assumed that this species is common and widespread across the site.

- **Water Buffalo (*Bubalus bubalis*)**

Impact from this species at the site is considered low, as there are no large permanent wetland areas where Water Buffalo are known to persist in larger numbers. Given the low number recorded, it is assumed that this species is uncommon across the site.

- **Feral Dog/Dingo Hybrid (*Canis sp.*)**

It is possible that this species preys upon local threatened fauna; however, it is also plausible that its presence keeps cat populations low. It is assumed that this species is common and widespread across the site.

- **Asian House Gecko (*Hemidactylus frenatus*)**

This species is not thought to significantly displace native species in a natural bushland environment, but will out-compete similarly-natured native geckos (such as *Gehyra australis*) in a domestic environment. This species was only observed incidentally in areas where human structures persist (including the telecommunications tower precinct).

The presence and abundance of these species within the project area are typical of the region.

Weed infestations

Four declared weeds were recorded within the project area:

- Gamba Grass (*Andropogon gayanus*)
- Mission Grass (*Cenchrus polystachios*)
- Hyptis (*Hyptis suaveolens*)
- Snake weed (*Stachytarpheta* spp.)

Infestations of these weeds are mapped in Figure 3-13. These species are all listed as Class B (spread to be controlled by landowners and occupiers) and Class C (not to be introduced) under the *Weeds Management Act*.

Weed density is fairly low across the project area. Gamba Grass and Mission Grass infestations were mainly located along tracks and other areas of disturbance. Hyptis was common along drainages. Snake Weed was common along the waterways on the western side of the project area.

Fire

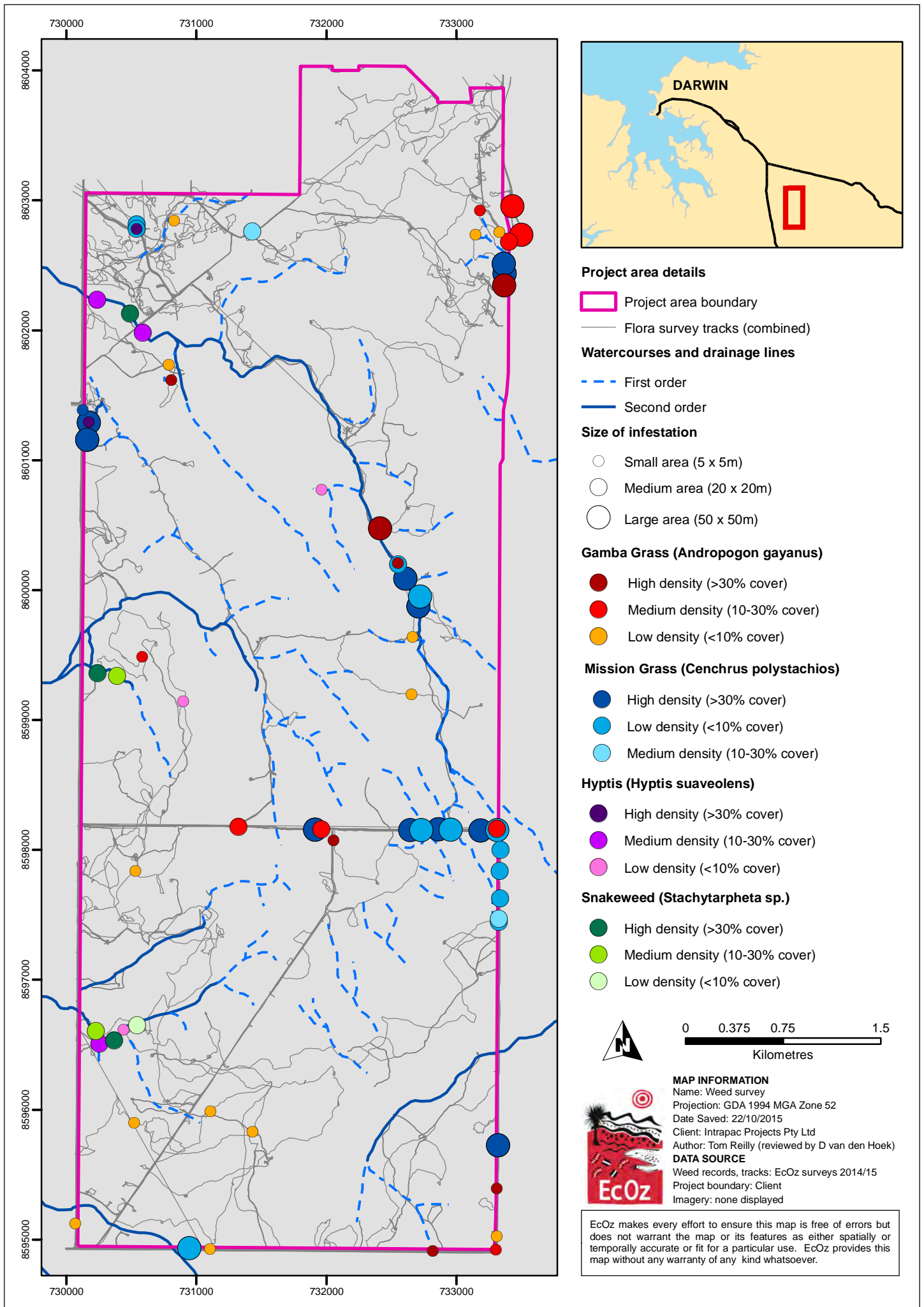
Typically about 39 % of Northern Australian savannahs burn each year in the dry season – Allen & Wilson (1995), Russell-Smith et al. (1997). For the Darwin region the figure is higher, with approximately 45 – 67 % of savannah burnt annually (the variation depending on the type of savannah) compared with only ~ 22 % of riparian forest and ~ 2 % dry rainforest (Price & Baker 2007). Only 5 % of savannah escaped being burnt over a nine-year period studied by Price & Baker (2007). That said, those authors concluded that in Darwin the overall fire regime is more benign than in most other parts of the savannahs because the frequency of late dry season fires (which burn hotter due to heavier fuel loads) is lower.

The project area – which is predominantly savannah woodland – reflects the abovementioned research, with widespread fires occurring across the project area 13 times over the past 14 years (see Figure 3-14). Every year at the end of the wet season (around May), the Elizabeth Valley Fire Brigade, on behalf of the landholders, burns the project area inwards for a few hundred metres along the western, northern and southern boundaries to create a buffer between the project area and adjacent residences (Dianne Tynam pers. comm.). Most of the remaining area – especially the ridge lines – experiences an annual mid-to-late dry season bushfire, usually unauthorised fires deliberately lit by ‘fire-bugs’.

The consensus within the literature on the impacts of the modern fire regime on Top End wildlife is that they are negative – see Price & Baker (2007) for a summary. The high burning frequency within the project area is likely to have changed the vegetation structure and flora diversity, and is likely to have reduced shelter opportunities (i.e. fallen hollow logs) and small tree abundances that supply food resources to a range of fauna species. Consequently, many birds and some mammals show a negative response to too frequent fires. Fire regimes with frequent late season burns are implicated as a possible cause for the declining of many small to medium size mammals across the tropical savannahs (Price & Baker 2007). When coupled with other threatening processes such as weeds and feral animals, fire can have a devastating impact on local flora and fauna populations. Gamba Grass, for instance, produces up to 40 times more fuel load than native grass understorey.

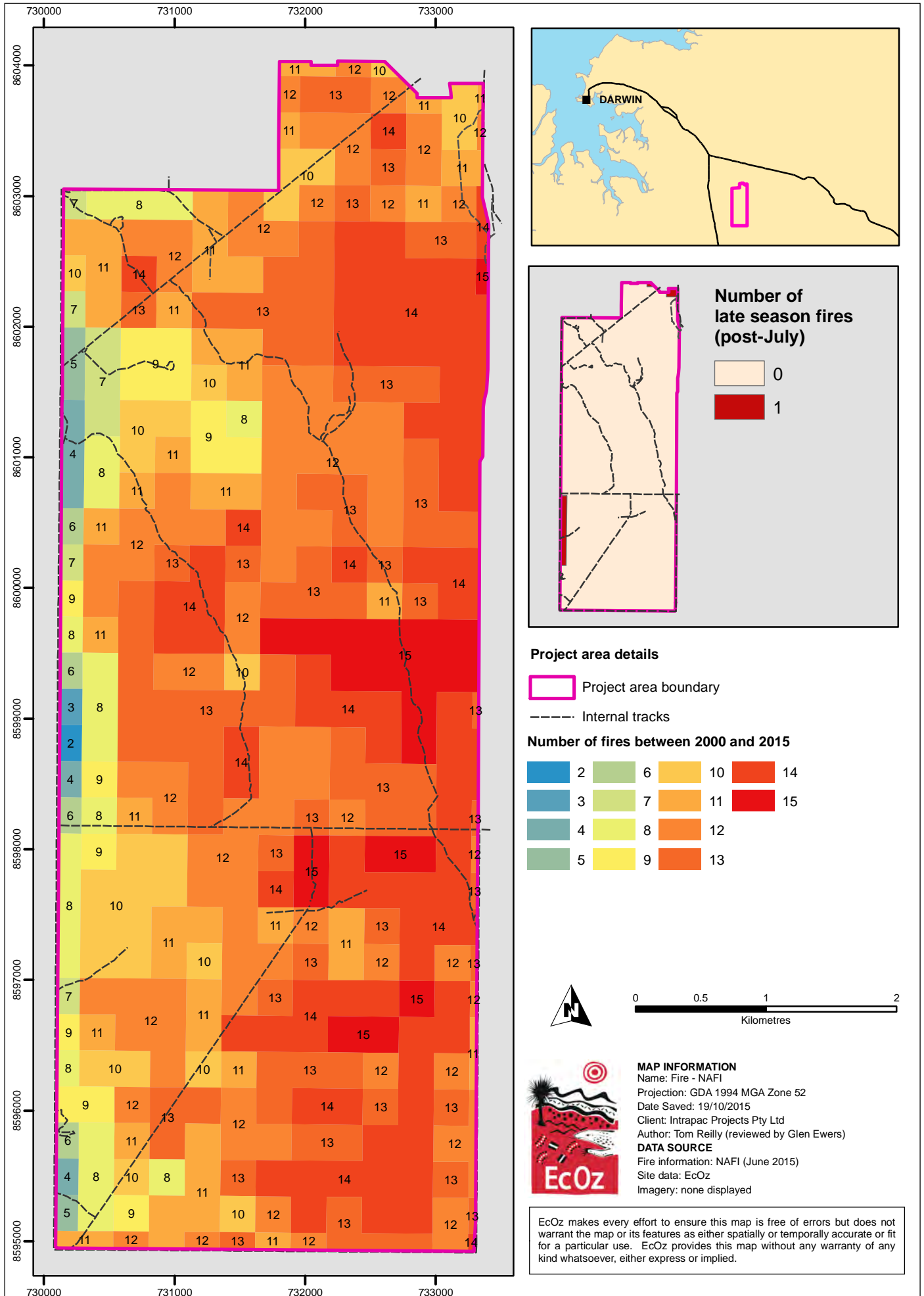
Land degradation

Approximately 0.6 % (17.7 ha) of the project area has been previously cleared for recreational tracks, a telecommunications tower, an abandoned quarry and numerous borrow pits/scrapes. Most of the cleared land is in the north-west corner of the project area (see Figure 3-15). Illegal dumping of rubbish and abandoned cars is common along the internal tracks.



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Figure 3-13. Map of declared weed species and associated densities within the project area



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Figure 3-14. Map of fire frequency and late burns within the project area between 2000 and 2015

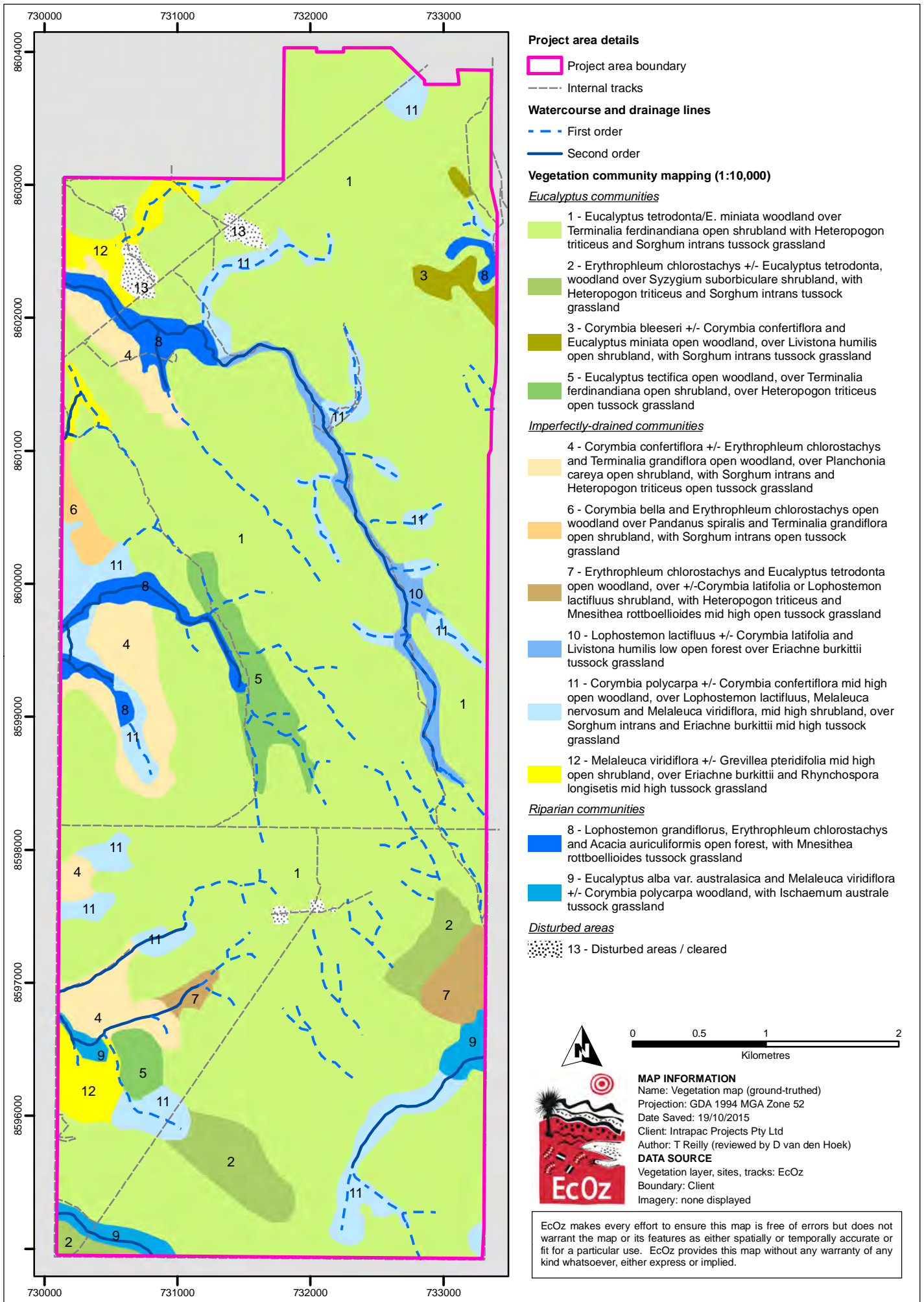
3.8 VEGETATION COMMUNITIES

Land unit mapping formed the basis of vegetation community mapping and was conducted prior to detailed vegetation surveys (see *Land Suitability Assessment* in Appendix G). From this, vegetation mapping of the project area to a scale of 1:10,000 was undertaken (see *Flora and Fauna Assessment Report* in Appendix I).

Twelve distinct vegetation communities occur within the project area – see Table 3-6 and Figure 3-15 – of which 74.2 % is *Eucalyptus tetradonta* and *E. miniata* woodland. The remaining vegetation types are associated with drainage lines or areas of seasonal inundation.

Table 3-6. Vegetation communities

Vegetation community		Area (ha)
Eucalyptus communities		
1	<i>Eucalyptus tetradonta</i> and <i>Eucalyptus miniata</i> mid high woodland over <i>Terminalia ferdinandiana</i> , <i>Erythrophleum chlorostachys</i> and <i>Planchonia careya</i> mid high open shrubland, over <i>Heteropogon triticeus</i> , <i>Sorghum intrans</i> and <i>Chrysopogon fallax</i> mid high tussock grassland.	2040.81 (74.2 %)
2	<i>Erythrophleum chlorostachys</i> +/- <i>Eucalyptus tetradonta</i> , mid high woodland over <i>Syzygium suborbiculare</i> mid high shrubland, over <i>Heteropogon triticeus</i> , <i>Sorghum intrans</i> , <i>Mnesithea rottboellioides</i> and <i>Alloteropsis semialata</i> mid high tussock grassland.	70.64 (2.6%)
3	<i>Corymbia bleeseri</i> +/- <i>Corymbia confertiflora</i> and <i>Eucalyptus miniata</i> mid high open woodland, over <i>Livistona humilis</i> , <i>Planchonia careya</i> and <i>Syzygium suborbiculare</i> mid high open shrubland, over <i>Sorghum intrans</i> mid high tussock grassland.	15.75 (0.6%)
5	<i>Eucalyptus tectifica</i> mid high open woodland, over <i>Terminalia ferdinandiana</i> mid high open shrubland, over <i>Heteropogon triticeus</i> mid high open tussock grassland	63.05 (2.3%)
Imperfectly-drained communities		
4	<i>Corymbia confertiflora</i> +/- <i>Erythrophleum chlorostachys</i> and <i>Terminalia grandiflora</i> mid high open woodland, over <i>Erythrophleum chlorostachys</i> , <i>Planchonia careya</i> and <i>Terminalia grandifolia</i> mid high open shrubland, over <i>Sorghum intrans</i> and <i>Heteropogon triticeus</i> mid high open tussock grassland.	125.16 (4.6%)
6	<i>Corymbia bella</i> and <i>Erythrophleum chlorostachys</i> mid high open woodland over <i>Pandanus spiralis</i> and <i>Terminalia grandiflora</i> mid high open shrubland, over <i>Sorghum intrans</i> mid high open tussock grassland.	14.3 (0.5%)
7	<i>Erythrophleum chlorostachys</i> and <i>Eucalyptus tetradonta</i> mid high open woodland, over +/- <i>Corymbia latifolia</i> or <i>Lophostemon lactifluus</i> , mid high shrubland, over <i>Heteropogon triticeus</i> , <i>Mnesithea rottboellioides</i> and <i>Eriachne burkittii</i> mid high open tussock grassland.	32.36 (1.2%)
10	<i>Lophostemon lactifluus</i> +/- <i>Corymbia latifolia</i> and <i>Livistona humilis</i> low open forest, over <i>Eriachne burkittii</i> mid high tussock grassland.	46.18 (1.7%)
11	<i>Corymbia polycarpa</i> +/- <i>Corymbia confertiflora</i> mid high open woodland, over <i>Lophostemon lactifluus</i> , <i>Melaleuca nervosum</i> and <i>Melaleuca viridiflora</i> , mid high shrubland, over <i>Sorghum intrans</i> and <i>Eriachne burkittii</i> mid high tussock grassland.	176.24 (6.4%)
12	<i>Melaleuca viridiflora</i> +/- <i>Grevillea pteridifolia</i> mid high open shrubland, over <i>Eriachne burkittii</i> and <i>Rhynchospora longisetis</i> mid high tussock grassland.	55.84 (2.0%)
Riparian communities		
8	<i>Lophostemon grandiflorus</i> , <i>Erythrophleum chlorostachys</i> and <i>Acacia auriculiformis</i> mid high open forest, over <i>Canarium australianum</i> , <i>Carpentaria acuminata</i> and <i>Clerodendrum floribundum</i> mid high shrubland, over <i>Mnesithea rottboellioides</i> and <i>Cheilanthes tenuiflora</i> mid high tussock grassland.	62.59 (2.3%)
9	<i>Eucalyptus alba</i> var. <i>australasica</i> and <i>Melaleuca viridiflora</i> +/- <i>Corymbia polycarpa</i> mid high woodland, over <i>Lophostemon lactifluus</i> and <i>Pandanus spiralis</i> mid high shrubland, over <i>Ischaemum australe</i> mid high tussock grassland.	29.24 (1.1%)



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Figure 3-15. Map of the ground-truthed vegetation communities within the project area

3.9 SIGNIFICANT CONSERVATION VALUES

3.9.1 Threatened species

Thirty-nine species were analysed as part of a threatened species' likelihood of occurrence assessment for the project area (see Section 3 of the *Flora and Fauna Assessment Report* – Appendix I).

The results of the assessment were that:

- Twenty species were ranked as having a 'high' or 'medium' chance of occurring within the project area. These species were therefore targeted during field studies.
- Nine species were ranked as having a low chance of occurring within the project area and so no specific survey techniques were carried out.
- Ten species were considered to not occur within the project area as it does not support critical habitat features for these species, or the species are considered locally extinct.

A flora and fauna survey program was then designed to target threatened species considered to have potential to occur within the project area based on known habitat requirements and distributions, as well as provide general observations on biodiversity, weed infestations, and pests. Survey methodology was tailored to align with standard NT survey guidelines and, where applicable, meet federal survey guidelines for EPBC-listed species. The results of the survey are reported in Appendix I.

Importance of threatened species' populations

When assessing the risk of impacts to threatened species that are known or likely to occur within the project area, it is necessary to first establish whether local populations are 'important' as defined in *EPBC Significant Impact Guidelines 1.1* (2013). This is a requirement within the Terms of Reference for the EIS for this project.

According to the guidelines, any occurrence of Critically Endangered and Endangered species within a project area constitutes a population, and all populations are considered 'important'.

For Vulnerable species, an 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- Key source populations either for breeding or dispersal
- Populations that are necessary for maintaining genetic diversity
- Populations that are near the limit of the species' range.

For the purposes of this EIS, 'important populations' are considered to be of conservation significance. The survey identified that the project area contains several conservation-significant threatened species that may need consideration during the EIS process – these are summarised in the following sub-sections.

3.9.2 Conservation-significant flora

Targeted surveys and habitat assessments were undertaken for ten flora species that are listed under the *TWPC Act* and/or the *EPBC Act*. Six species – *Atalaya brevialata*, *Typhonium taylori*, *Utricularia dunstaniae*, *Utricularia singeriana*, *Utricularia holtzei* and *Stylidium ensatum* – were not found during the surveys, nor was suitable habitat identified. Therefore, they are considered unlikely to occur within the project area and have not been considered further. The importance of the recorded populations of the four remaining species is discussed below.

Spiderflower (Cleome insolata)

This species is listed as Vulnerable under the *TPWC Act* and is not listed under the *EPBC Act*.

A significant population of Spiderflower was identified in the north-western corner of the project area (see Figure 3-16 and Figure 3-17). The survey recorded three sub-populations within this area and counted 207 individuals (noting that surveys were focused on the population extent rather than counting all records of the species). The population occurs within gravel heath vegetation community (seasonally-inundated *Melaleuca viridiflora* open woodland with a surface gravel layer). This is possibly the largest known population of the species anywhere. It is likely to be a key source population for breeding and/or dispersal – and therefore constitutes an ‘important population’.

Two smaller populations of Spiderflower were also found in roadside drains along Redcliffe Road (see Figure 3-16); these are outside of the project area and are located in an impacted habitat. Nevertheless, given that prior to these surveys there were only two other known populations of Spiderflower, these two smaller populations that occur adjacent to the project area are also considered significant.

In summary, the population of Spiderflower within the project area **is** considered to be of conservation significance.

Typhonium praetermissum

This species is listed as Vulnerable under the *TPWC Act* and is not listed under the *EPBC Act*.

Typhonium praetermissum populations occur within the project area on a number of different land units that support Vegetation Community 1. Populations were ascribed a qualitative category of high, medium or low to inform assessment of conservation significance and future management decisions for the species within the project area (see Figure 3-16 and Figure 3-17). The categories were defined – in consultation with Ian Cowie from the NT Herbarium – according to the number and proximity of individuals, and the quality of habitat. The results of the survey determined there are four populations of *T. praetermissum* with high conservation significance within the project area (two in the north-west and two in the south-west), and a number of populations with medium or low level of conservation significance in the north-eastern and southern sections of the project area.

Given their extent, the high conservation significance populations are likely to be key source populations for breeding and/or dispersal, and hence are considered ‘important populations’. The remaining populations were determined to have a low level of conservation significance due to the small population size, low density and it being sub-optimal habitat for the species’ requirements. These are not considered as ‘important populations’ and are therefore not presented as significant biodiversity features in Figure 3-16 and Figure 3-17.

In summary, the populations of *Typhonium praetermissum* within the project area shown in Figure 3-16 and Figure 3-17 **are** considered to be of conservation significance.

Darwin Cycad (Cycas armstrongii)

This species is listed as Vulnerable under the *TPWC Act* and is not listed under the *EPBC Act*.

The Darwin Cycad population within the project area is widespread and is contiguous with that of the vast area of savannah woodland to the east. The population, therefore, is unlikely to contribute significantly to the species’ genetic diversity or to constitute a key source population either for breeding or for dispersal. Moreover, the project area is within the heartland for this species rather than being the limit of its range. For these reasons, the population of Darwin Cycad within the project area is not considered necessary for the species’ long-term survival and recovery, and therefore is not an ‘important population’. It not presented as a significant biodiversity value in Figure 3-16 and Figure 3-17.

In summary, the population of Darwin Cycad within the project area **is not** considered to be of conservation significance.

Utricularia hamiltonii

Utricularia hamiltonii is listed as Near Threatened under the *TWPC Act* and was identified in the Terms of Reference as a species of conservation significance that needs to be assessed for potential impacts from the project.

A small population (three plants) of *U. hamiltonii* was located within the drainage area in the north-western corner of the project area (which is in the same area and habitat type as several other threatened species located during the survey program). This species is spread widely throughout the Municipality of Litchfield – including the Howard River floodplain, Adelaide River floodplain and McMinns Lagoon. As such, it is unlikely that the small population within the project area contributes significantly to the species' genetic diversity or constitutes a key source population either for breeding or for dispersal. Moreover, the project area is within the heartland of this species rather than being at the limit of its range. For these reasons, the population of *U. hamiltonii* within the project area is not considered necessary for the long-term survival and recovery, and therefore is not considered an 'important population'.

In summary, the population of *Utricularia hamiltonii* within the project area **is not** considered to be of conservation significance.

3.9.3 Conservation-significant fauna

Targeted surveys and habitat assessments were undertaken for ten fauna species that are listed under the *TWPC Act* and/or the *EPBC Act*. Three species – Floodplain Monitor (*Varanus panoptes*), Masked Owl (*Tyto novaehollandiae kimberli*) and Northern Quoll (*Dasyurus hallucatus*) – were not found during the surveys, and conditions within the project area are such that they are considered unlikely to occur. For three other species – Bare-rumped Sheath-tailed Bat (*Saccolaimus saccolaimus*), Fawn Antechinus (*Antechinus bellus*) and Pale Field-rat (*Rattus tunneyi*) – there is suitable habitat and recent local records, but they were not detected within the project area despite robust survey methodology. These six species have therefore not been considered further. The importance of the populations of the remaining four species is discussed below.

Howard River Toadlet (Uperoleia daviesae)

This species is listed as Vulnerable under the *TPWC Act* and is not listed under the *EPBC Act*.

Two large populations and one small population were identified within the project area (see Figure 3-16 and Figure 3-17). They occur in the north-west of the project area in seasonally-inundated areas that are characterised by sandsheet heath vegetation. Several other isolated records were also found; however, these were single individuals located in sub-optimal habitat and are therefore not considered to constitute a significant conservation value (hence their exclusion from Figure 3-16 and Figure 3-17).

Population 1 possibly represents the largest known population of Howard River Toadlet anywhere; the abundance of the species within Population 2 is less understood, but may be of a similar size. Population 3 had fairly low activity but is the most southern known population of this species (although there are two separate singular records in the southern portion of the project area). Each of these populations are regarded as necessary for maintaining genetic diversity and are valuable as source populations for breeding, especially because of their relative isolation from other known populations and the fact that they occur on the periphery of this species' range. Therefore, the two large populations and one small population that occur within the project area all constitute 'important populations'.

In summary, three populations of Howard River Toadlet within the project area **are** considered to be of conservation significance.

Mertens' Water Monitor (Varanus mertensi)

This species is listed as Vulnerable under the *TPWC Act* and is not listed under the *EPBC Act*.

Mertens' Water Monitors were identified along creek lines within the project area during the wet season (five separate records). The observation of five individuals in multiple drainage systems suggests that *V. mertensi* is common within the project area in suitable habitat (namely the riparian vegetation). There are numerous small populations of this species in the riparian zones around the NT – including in the greater Darwin region – and the project area is not at this species' limit. Therefore, it cannot be reasonably said that the project area contains an 'important population' necessary for the species' long-term survival and recovery of the Mertens' Water Monitor.

In summary, the population of Mertens' Water Monitors within the project area **is not** considered to be of conservation significance.

Partridge Pigeon (Geophaps smithii smithii)

This species is listed as Vulnerable under the *TPWC Act* and the *EPBC Act*.

The results from the survey confirm that Partridge Pigeon utilise habitat within the project area (all sightings occurred in the wet season within Vegetation Community 1 – *Eucalyptus tetradonta* and *E. miniata* woodland). These sightings may constitute a reasonably intact population associated with the bushland to the east of the project area. However, the degree to which the population depends on the project area is unknown. In the absence of longer term and more widespread studies (i.e. in suitable habitat surrounding the project area), and the fact that the records of this species within the project area are the closest recent records to Darwin, the local population of this species is considered a population near the limit of the species' range, and therefore an 'important population'.

In summary, the population of Partridge Pigeon that utilises the project area **is** considered to be of conservation significance.

Black-footed Tree-rat (Mesembriomys gouldii)

This species is listed as Vulnerable under the *TPWC Act* and Endangered under the *EPBC Act*.

At least one population of Black-footed Tree-rat is present within the project area, and it can be surmised that longer term studies within other riparian areas that occur within the project area may also have detected Black-footed Tree-rats (due to presence of suitable habitat and linkages to areas where the species has been previously located or are highly likely to occur).

A population of an Endangered species is defined as any occurrence of the species in a particular area, and any population is considered an 'important population'. Therefore, it has to be considered that an 'important population' of the Black-footed Tree-rat utilises the riparian vegetation within the project area.

In summary, the population of Black-footed Tree-rat within the project area **is** considered to be of conservation significance.

3.9.4 Conservation-significant vegetation types

Four sensitive vegetation types were identified within the project area – sandsheet and gravel heath, riparian vegetation, dry monsoon forest and wetlands. Some of these are considered to be of conservation significance; their distribution within the project area is mapped in Figure 3-16 and Figure 3-17. Reasons justifying their conservation significance are discussed below:

- Three areas of **sandsheet heath** vegetation were identified within the project area during a 1:5,000 mapping exercise; however, only one of these areas is considered significant due to the presence of large populations of two threatened species – Howard River Toadlet (*Uperoleia daviesae*) and Spiderflower (*Cleome insolata*). This is located in the north-west corner of the project area and comprises sandsheet heath (7 ha) and gravel heath (9 ha), totalling approximately 0.6 % of the project area. Howard River Toadlet was observed to occur in both sandsheet and gravel heath habitat (however, substantially more numbers were observed in sandsheet). Spiderflower was only found in gravel heath.

The two remaining areas of heath vegetation that occur within the project area consist of sandsheet heath (no gravel heath association); however, targeted surveys within these areas did not record the presence of significant populations of threatened species.

- **Riparian vegetation** onsite is restricted to the second order streams within Vegetation Communities 8 and 9, which equates to approximately 91.8 ha (3.4 % of the project area). Two threatened species were confirmed to utilise this habitat type – Mertens' Water Monitor (*Varanus mertensi*) and Black-footed Tree-rat (*Mesembriomys gouldii*).
- A small patch of **dry monsoon forest** is located in the north-east corner of the project area and covers approximately 2 ha. No threatened species were recorded during the surveys from within the patch (nor were they expected to be). Monsoon forest vegetation types are significant because they provide high biodiversity values for the local region.
- Two types of freshwater **wetlands** were identified within the project area – seasonal swamps and a permanent soak. There are four swamps, all linked to ephemeral second-order streams and all within riparian Vegetation Communities 8 and 9. No threatened or migratory species were identified within these, and the small size and seasonality of the swamps indicates they are not significant habitat features for the region. One permanent soak is located within one of the seasonal drainages in the centre of the project area. This is likely to be the only permanent onsite water source and hence is regarded as a locally-important waterhole for fauna.

3.9.5 Summary of conservation significance

The significant conservation values within the project area are depicted in Figure 3-16 and Figure 3-17, and are summarised below.

Sensitive vegetation types

The following areas of sensitive vegetation types within the project area are considered to be of conservation significance:

- One area of sandsheet heath
- All areas of riparian vegetation
- The only patch of dry monsoon forest
- All wetlands.

Threatened species

The following threatened species occur in 'important populations' within the project area and **are** therefore considered to be of conservation significance:

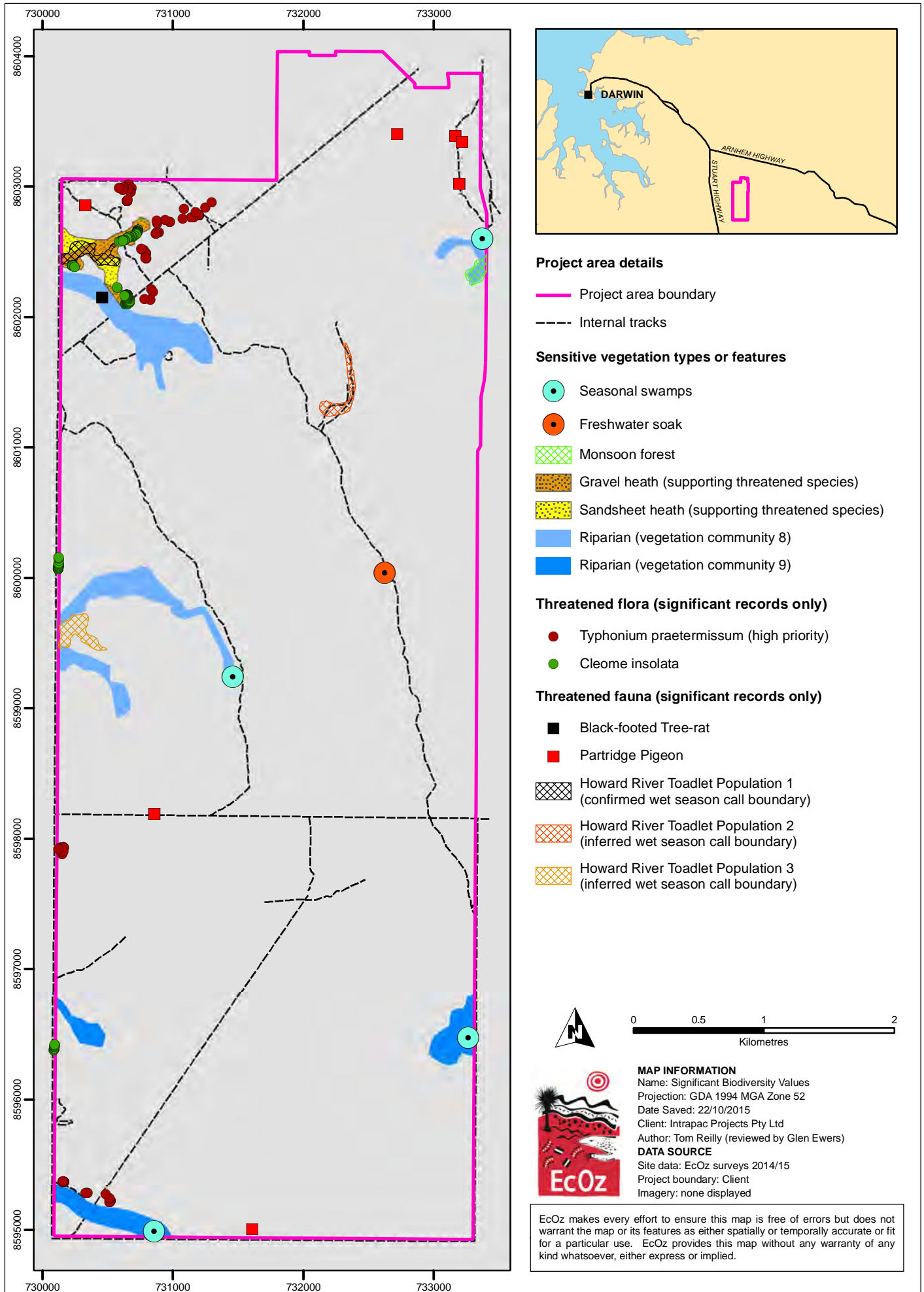
- Spiderflower (*Cleome insolata*) – the sole population
- *Typhonium praetermissum* – the populations identified in Figure 3-16 and Figure 3-17
- Howard River Toadlet (*Uperoleia daviesae*) – the populations identified in Figure 3-16 and Figure 3-17
- Black-footed Tree-rat (*Mesembriomys gouldii*) – the entire population
- Partridge Pigeon (*Geophaps smithii smithii*) – the entire population.

The following threatened species were identified within the project area, but not in 'important' populations. Therefore, they **are not** considered to be of conservation significance within the project area.

- Darwin Cycad (*Cycas armstrongii*)
- Mertens' Water Monitor (*Varanus mertensi*).

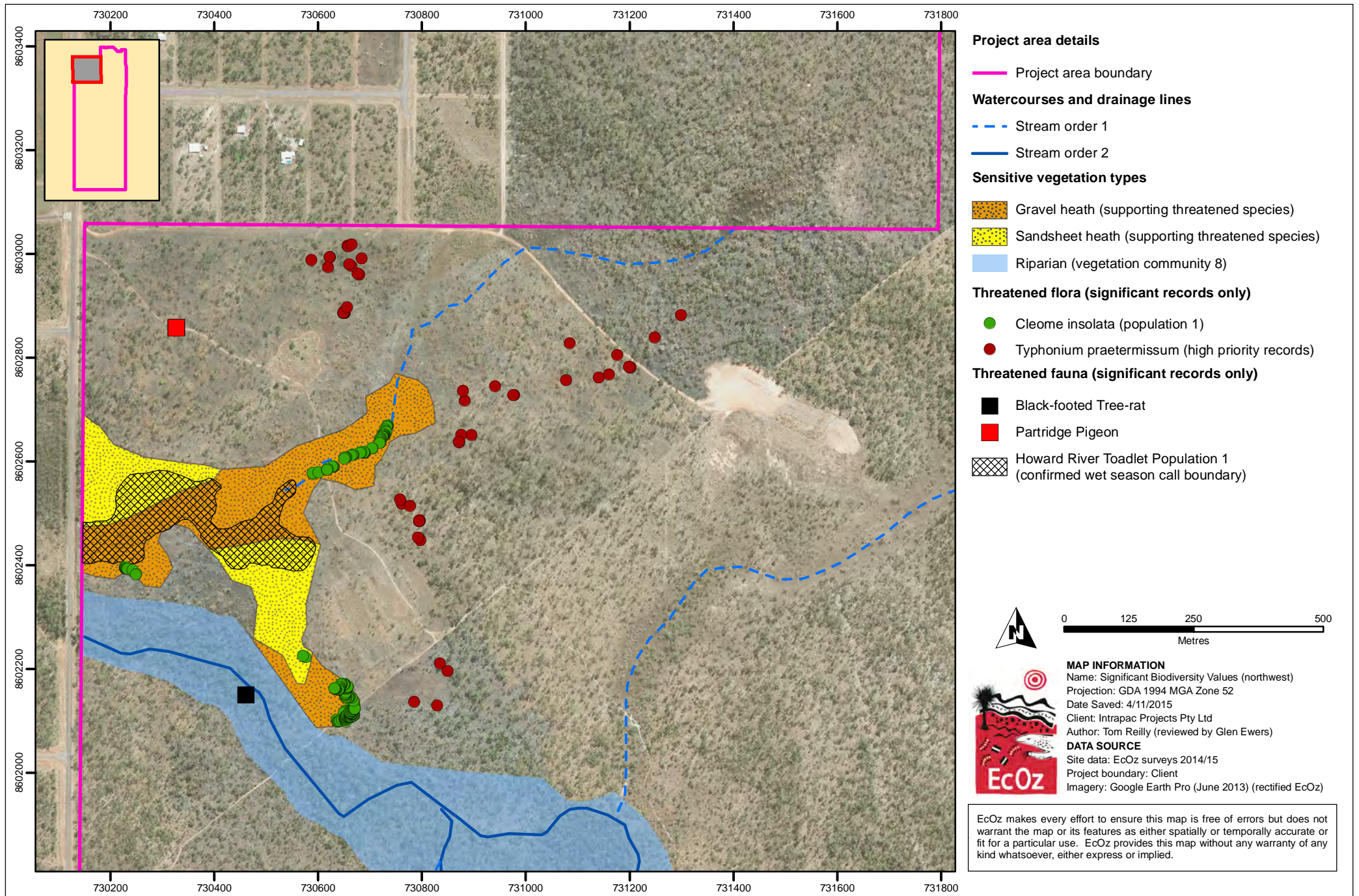
The following Near Threatened species were identified within the project area, but not in 'important' populations. Therefore, they **are not** considered to be of conservation significance within the project area.

- a Bladderwort (*Utricularia hamiltonii*)
- Bush Stone-curlew (*Burhinus grallarius*)
- Northern Brown Bandicoot (*Isodon macrourus*)
- Common Brushtail Possum (*Trichosurus vulpecula arnhemensis*).



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Figure 3-16. Map of the conservation-significant values identified within the project area



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Figure 3-17. Map of the conservation-significant values identified within the north-west corner of the project area

3.10 CONSERVATION RESERVES

The nearest conservation areas to the project area are Black Jungle/Lambells Lagoon Conservation Reserve located approximately 9 km to the north-east of the project area and Fogg Dam Conservation Reserve located approximately 13 km to the north-east of the project area (see Figure 3-18). Neither of these reserves receive surface water flows originating from the project area and they are therefore both outside of the project's footprint.

3.11 SITES OF CONSERVATION SIGNIFICANCE

DLRM has identified 67 of the most important sites for biodiversity conservation for the NT. The project area is bordered by three of these Sites of Conservation Significance (information from Harrison et al. (2009) and see Figure 3-19):

- **Darwin Harbour** – the western portion of the project area drains into the Elizabeth River, which flows into Darwin Harbour. The area has one of the richest coastal environments anywhere in the Asia-Pacific region, and occurs within one of the world's least impacted marine regions. Fire, feral animals, weeds, rise in sea level and reduced water quality because of development within the catchment are considered the key management issues for this site.
- **Adelaide River coastal floodplain** – the south-eastern portion of the project area drains into the Adelaide River, which flows through the area defined as a Site of Conservation Significance. The upper and middle parts of the floodplain provide core nesting habitat for Magpie Geese, and the largest waterbird breeding colony in the NT is found in mangroves in the lower reaches of the Adelaide River. Parts of this site are listed as a Wetland of National Significance in the *Directory of Important Wetlands in Australia*. Fire, feral animals, weeds, rise in sea level and saltwater intrusion are considered the key management issues for this site.
- **Howard sand plains** – this Site of Conservation Significance is situated around the Howard River to the north of the project area, with its southern boundary overlapping the north-western corner of the project area. The Howard sand plains are a unique environment that supports distinct vegetation types consisting of heathlands, open woodlands, sedgeland and grasslands. Many plant and animal species have adapted to, and are largely or entirely restricted to, this habitat type – including the Howard River Toadlet (*Uperoleia daviesae*) and at least 26 bladderwort species, several of which are rare.

Land clearing for mineral extraction, and rural and agricultural expansion, are currently the most significant management issues affecting the conservation values of the Howard sand plains. Recreational misuse of these sensitive environments is increasingly apparent as the population of Darwin continues to grow. This includes 'fire-bug' activity, leading to increased frequencies of fires in some areas. Exotic grasses are also becoming more widespread and fuelling hotter and more destructive fires.

All of these Sites of Conservation Significance are recognised as being of international conservation significance; however, none of the sites are afforded any legislated protection. The NTEPA have released for public comment a draft *Environmental Quality Report – Biodiversity of the Howard Sand Plains Site of Conservation Significance* (2015) which indicates that the preferred option for protection of the threatened biodiversity is to establish a protected area over the entire seasonally-inundated and water-logged area of the sand plains.

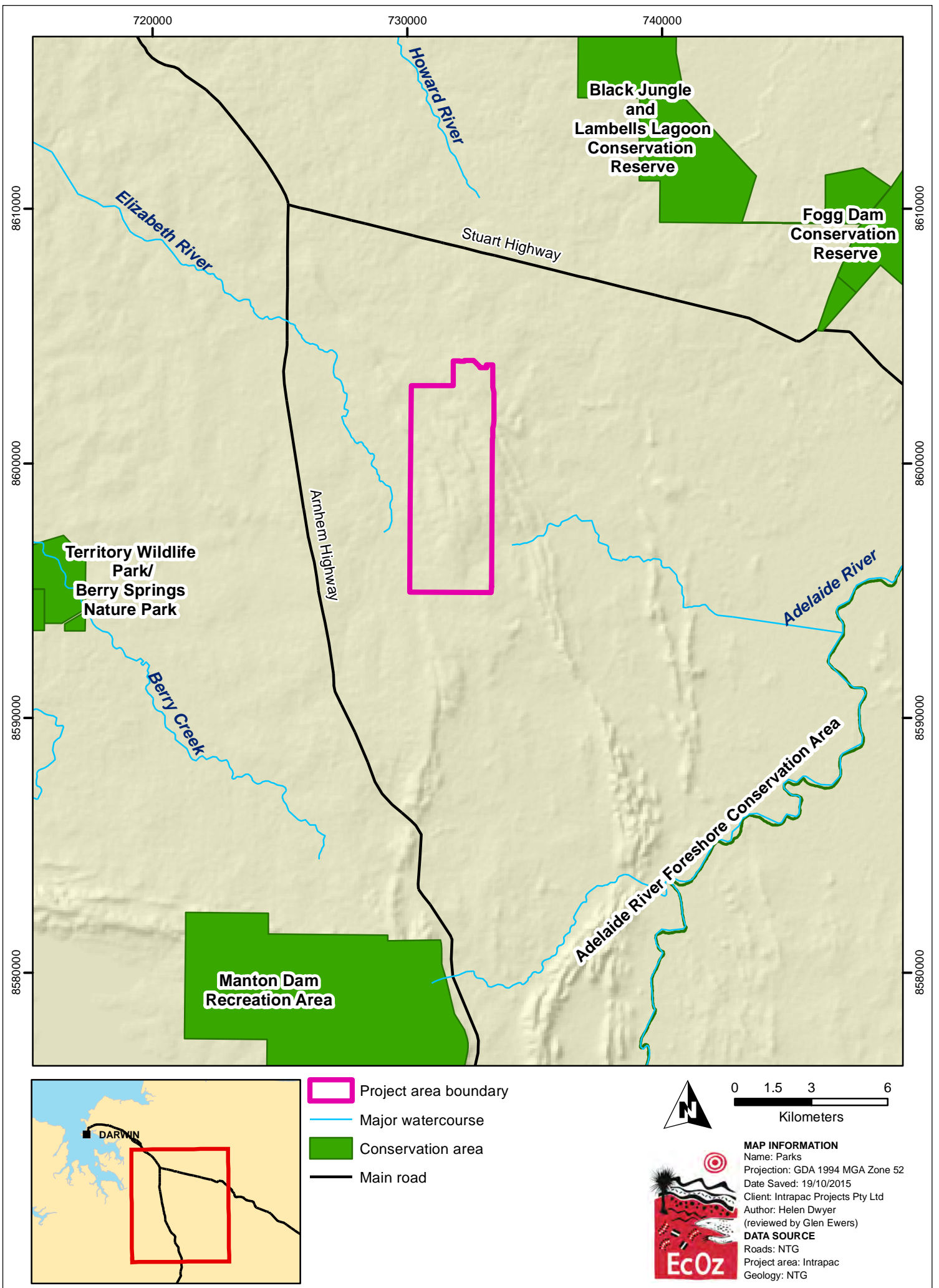


Figure 3-18. Map of the conservation reserves surrounding the project area

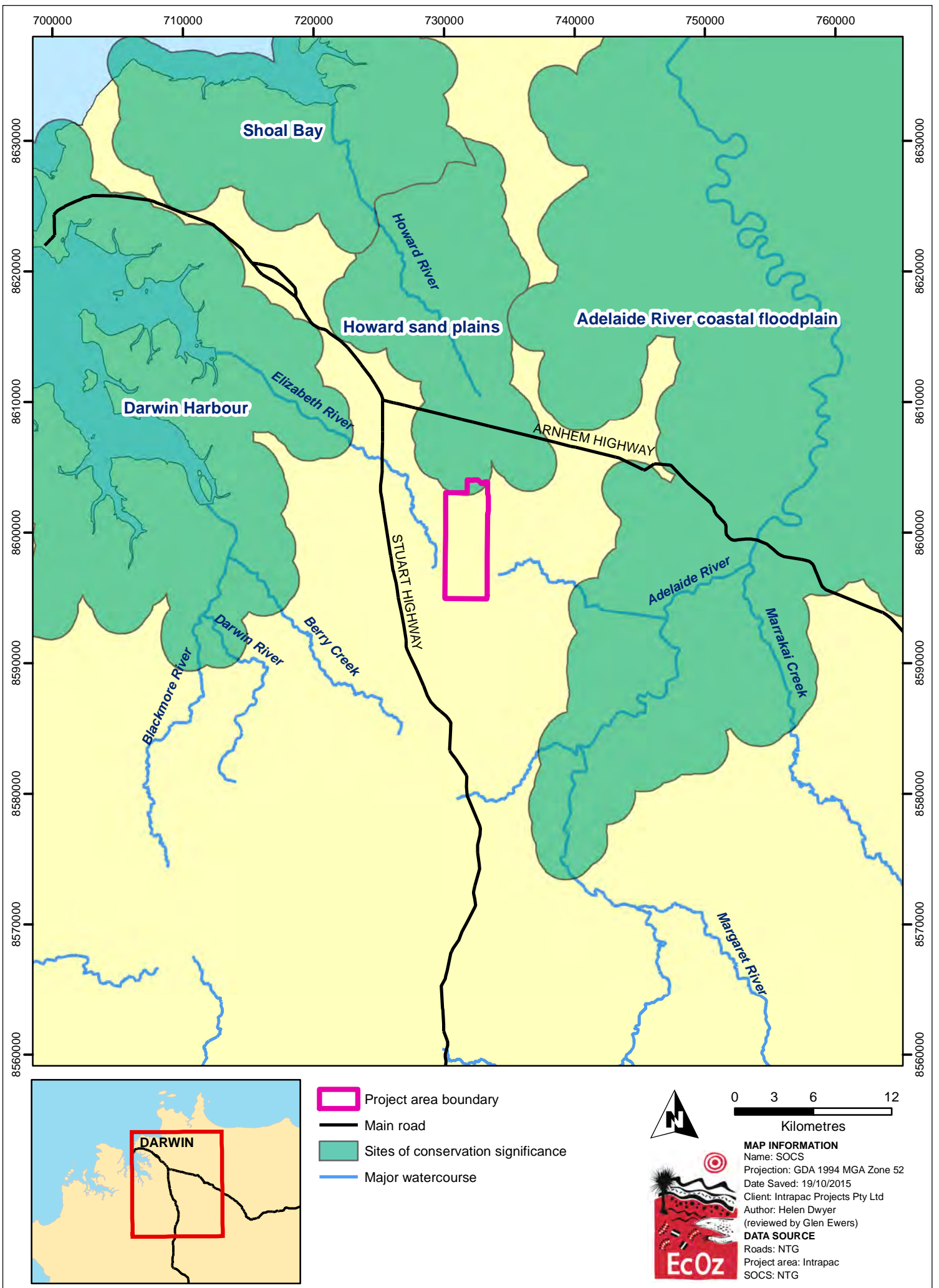


Figure 3-19. Map of Sites of Conservation Significance in relation to the project area

3.12 PRIORITY ENVIRONMENTAL MANAGEMENT AREAS

Parts of the project area are considered Priority Environmental Management Areas within the Municipality of Litchfield (see Figure 3-20 which is derived from the Priority Environmental Management Areas map accessible via the DLPE [website](#)). Proposals to develop land identified as Priority Environmental Management Areas must demonstrate consideration of the environmental significance of natural vegetation and other landscape features, and must retain and protect those areas (DIPE 2002). The Priority Environmental Management Areas within the project area largely align with the second order waterways along the western boundary.

3.13 BITING INSECTS

An assessment of biting insects within the project area was completed by the Medical Entomology division of the Department of Health (see Appendix K). The assessment included identification of potential breeding habitat for biting insects and trapping to identify species' abundance and diversity across the project area.

The survey trapping – conducted during peak abundance periods in January 2015 – identified 21 mosquito species, the most abundant of which was the Common Banded Mosquito (*Culex annulirostris*). This mosquito species is the principal vector of mosquito-borne disease in the NT – capable of transmitting Ross River virus, Barmah Forest virus and Murray Valley encephalitis virus. The very high numbers of Common Banded Mosquito trapped in January indicates that there is a high risk of transmission of Ross River Virus within the project area, particularly during peak season (mid-wet season). Other abundant species included *Culex vishnui* group and the *Culex pullus*.

The widespread incidence of high numbers of the Common Banded Mosquito suggests there are numerous productive breeding sites affecting the proposed development. The major breeding sites appear to be:

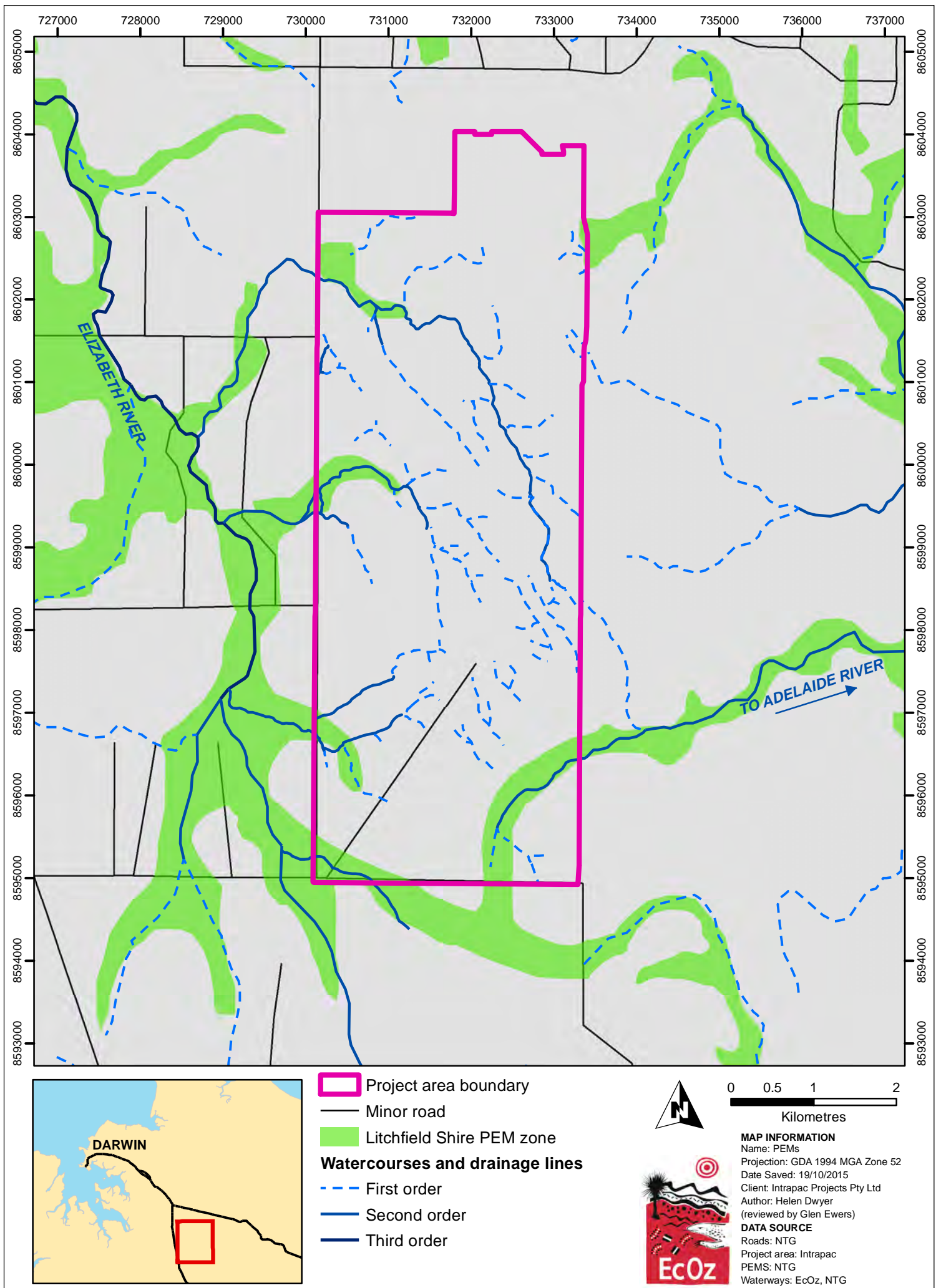
- Externally, the large seasonal swamps north of Goode Road and the seasonally-flooded areas to the west of Redcliffe Road; particularly within a 1.6 – 2 km radius around these areas.
- Within the project area, the borrow pits in the north, several vehicle-disturbed grassy drainage lines and localised swamps near the south-west corners of the development.

Potential breeding sites affecting the proposed development are shown in Figure 3-21.

The sandsheet heath drainage area in the northern portion of the project area does not have the characteristics of an important mosquito breeding area. However, this habitat may be a localised source of mosquitoes during the wet season.

Several *Anopheles* mosquito species were recorded during trapping. *Anopheles*-species mosquitoes are regarded as potential vectors of malaria. The species *Coquillettidia xanthogaster* was also recorded during trapping and, while it is not considered a vector for viruses, it can be a serious pest mosquito. The peak period for these mosquitoes is usually the late wet to mid-dry season. The nature of the seasonally-flooded areas in, and nearby to, the project area suggests that the late wet and early dry season breeding period is likely to be relatively short because inundated areas dry out quickly with the onset of the dry season. Therefore, it is expected that April to June would be the peak months of abundance for these mosquitoes.

There is a potential that during exceptional tidal mosquito-breeding events in the distant Adelaide River – most likely during November and December each year – the Northern Salt Marsh Mosquito (*Aedes vigilax*) would disperse to the project area from tidal swamps in the Adelaide River. This mosquito is a potential vector of Ross River virus and Barmah Forest virus.



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Figure 3-20. Map of the project area in relation to Priority Environmental Management Areas

3.14 CULTURAL HERITAGE

Cultural heritage refers to Aboriginal sacred and archaeological sites, and post-European settlement historic sites.

3.14.1 Sacred sites

An Aboriginal Areas Protection Authority certificate (C2015/111) has been acquired for the project area (see Appendix M). It identifies a sacred site (5172-61) immediately to the south-east of the project area, with an associated Restricted Works Area within the project area (see Figure 3-22). The sacred site features a spring.

3.14.2 Archaeological sites

An archaeological survey was conducted in November 2014 (see Appendix L). Seven stone artefact scatters were found, predominately on low laterite ridges adjacent to creeks. The artefacts were made of quartz and quartzite flakes, debitage (debris and discards from the making of tools and weapons) and some core stones.

One of the scatters was found in a rock shelter sufficiently large enough to hold deep deposits, although no excavation was undertaken to confirm this. The vertical surfaces of the shelter are heavily weathered and are not suitable as a rock art surface. The site is of high significance because of the excavation potential it offers. It is unique to the region as there is no other rock shelter site recorded this close to Darwin.

The remaining artefact sites are regarded as being of medium or low significance. Six isoliths (isolated stone artefacts) were also recorded (all quartz and quartzite), but no fine-grained material – such as chert and silcrete – was found. The isoliths are all considered to be of low significance.

These survey results indicate that Aboriginal people were mainly exploiting the low-lying and flat laterite ridges adjacent to main creeks and waterways. Water is always a key determinate as to where people lived in the environment. It would appear that occupation was focused in the northern sector of the survey area where there is dissection of the country by the quartzite ridges and major waterways. People were utilising locally-sourced raw materials – mainly quartzites and quartz – to produce stone tools.

All Aboriginal archaeological sites found within the project area are shown in Figure 3-23.

3.14.3 Heritage sites

There is a World War II bomber crash site located within the project area. To avoid disturbance to the site, the location is being withheld. The wreck is of a 15 tonne B-25D 'Mitchell', a twin-engine medium bomber. The aircraft was attached to No. 18 Squadron (Dutch) Royal Australian Air Force. The pilot, Sergeant C.A.H. Keesmaat, was killed in the crash; the rest of the crew parachuted out. Keesmaat was buried in an Indonesian cemetery; the site is therefore not a war grave. However, it is significant, as further analysis may indicate what happened to the aircraft at time of loss. The aircraft, its crew and the crash event are all poorly known, and the site is not listed on the NT Heritage Register.

In the north-western corner of the project area is a memorial cross for Glenn Lewis. Little is known about this, apart from the fact that Glenn Lewis died in 1991 and that he is not buried on the site (Silvano Jung pers. comm.)

3.15 AIR QUALITY

The project area is located immediately adjacent to the Darwin airshed where the major air pollutant of concern is particles from bushfire smoke in the dry season. Reporting prepared by the NTEPA (2012) indicates that there are currently no other significant sources of particles affecting the region apart from localised impacts associated with land clearing and urban development.

The ambient air quality within the project area can be considered equivalent to that of any natural environment setting, influenced by natural dust kicked up during wind and smoke from proximate burning-off and bushfires during the dry season. These conditions may be augmented by dust produced from the quarry on the eastern side of the project area.

Wind speed and direction influences the spread and transport of any air emissions – these are described in Section 3.1.

3.16 NOISE

The noise amenity in the vicinity of the project area comprises natural noise sources (e.g. birds and insects), traffic along Redcliffe and Goode Road, use of motorbikes and quad bikes on the site, and occasional noise associated with residential rural living. On the eastern side of the project area there is also an operating quarry with associated blasting and truck traffic.

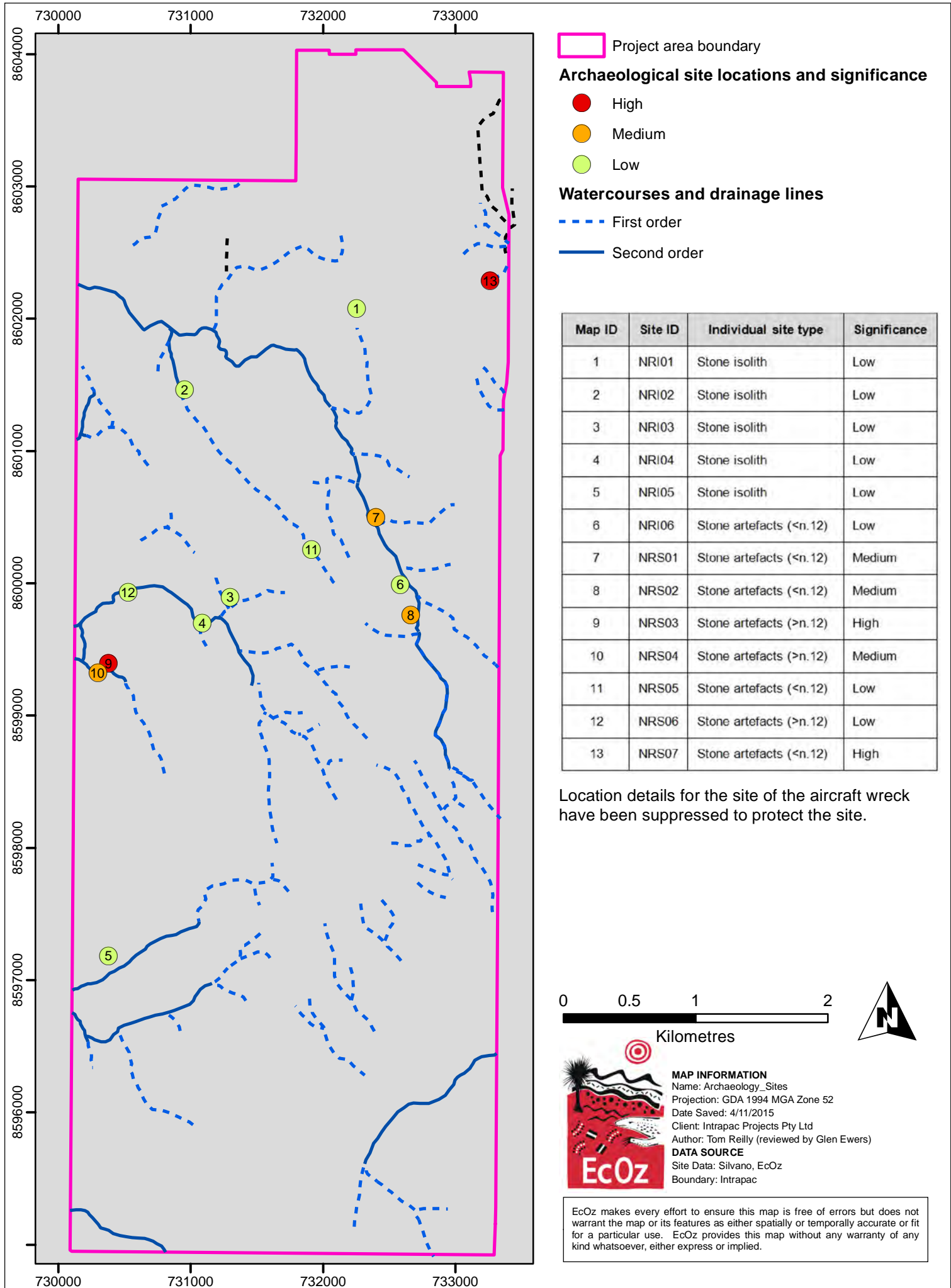


Figure 3-23. Map of the archaeological and heritage sites within the project area