Appendices

Appendix A: Commonwealth Protected Matters Search Tool

Australian Government
Department of the Environment and Energy

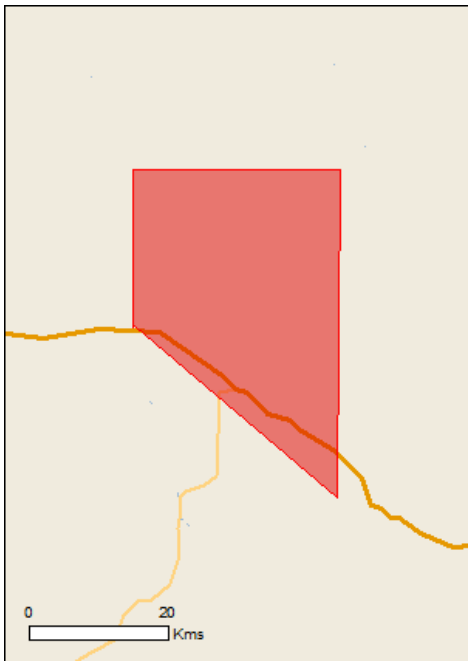
EPBC Act P Matt tt s R p t

This p t p vi s g n al gui anc n matt s f nati nal nvi nmental significanc an th matt s p t ct by th EPBC Act in th a a y u hav s l ct .

Inf mati n n th c v ag f this p t an ualificati ns n ata supp ting this p t a c ntain in th cav at at th n f th p t.

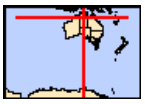
Inf mati n is availabl ab ut Envi nment Ass ssments an th EPBC Act inclu ing significanc gui lin s, f ms an applicati n p c ss tails.

R p t c at : 04/12/18 14:34:12



This map may c ntain ata which a q
©C mmonw alth f Aust alia
(G e sci nc Aust alia) A©P 1

C inat s
Buff : 10.0Km



Summary

era of Na onal nv ronmen al S gn f cance

Th ar of he re or ummar e he ma er of na onal env ronmen al gn f cance ha may occur n, or may rela e o, he area you nom na ed. Fur her nforma on ava lable n he de a l ar of he re or , wh ch can be acce ed by croll ng or follow ng he l nk below. If you are ro o ng o under ake an ac v y ha may have a gn f can m pac on one or more ma er of na onal env ronmen al gn f cance hen you hould con der he Adm n ra ve Gu del ne on S gn f cance.

World Her age Pro er e :	None
Na onal Her age Place :	None
We land of In erna onal Im por ance: M	None
Grea Barr er Reef Ma ne Park:	None
Commonweal h ar ne Area: M	None
L ed Threa ened colog cal Commun e :	None
L ed Thr ened S ec e :	12
L ed gra ory S ec e :	13

O her era Pro ec ed by he EPBC Ac

Th ar of he re or ummar e o her ma er ro ec ed under he Ac ha may rela e o he area you nom na ed. roval may be requ red for a ro o ed ac v y ha gn f can ly affec he env ronmen on Commonweal h land, when he ac on ou de he Commonweal h land, or he env ronmen anywhere when he ac on aken on Commonweal h land. A roval may al o be requ red for he Commonweal h or Commonweal h agenc e ro o ng o ake an ac on ha l kely o have a gn f can m pac on he env ronmen anywhere.

The EPBC Ac ro ec he env ronmen on Commonweal h land, he env ronmen from he ac on aken on Commonweal h land, and he env ronmen from ac on aken by Commonweal h agenc e . A her age value of a lace are ar of he 'env ronmen ', he e a ec of he EPBC Ac ro ec he Commonweal h Her age value of a Commonweal h Her age lace. Informa on on he new her age law can be found a h ://www.env ronmen .gov.au/her age

A erm i may be requ red for ac v e n or on a Commonweal h area ha may affec a member of a l ed hrea ened ec e or ecolog cal commun y, a member of a l ed m gra ory ec e , whale and o her ce acean , or a member of a l ed mar ne ec e .

Commonweal h Land:	None
Commonweal h Her age Place :	None
L ed r ne S ec e : M	20
Whale and O her Ce acean :	None
r cal Hab :	None
Commonweal h Re erve Te re r al:	None
Au ral an r ne Park : M	None

Ex ra Informa on

Th ar of he re or rov de nforma on ha may al o be relevan o he area you have nom na ed.

S a e and Terr ory Re erve :	None
Reg onal Fore Agreemen : M	None
Inva ve S ec e : M	11
Na onally Im por an We land :	None
Key Ecolog cal Fea ure (r ne)	None M

Details

Matte s of National Envi onmental Significance 8

Liste eatene Species 8		[Resou ce Info mation] 8
Name 8	Status 8	ype of P esence
Bi s		
Cali is fe uginea		
Cu8lew San pipe [56] 88	C itically En ange e	pecies o species abitat may occu wit in a ea
E yt ot io c is a iatus		
Re Gos awk [942] 8	Vulne able 8	Species o species abitat likely to occu wit in a ea
E yt u a goul iae		
Goul ian Finc [413] 8	En ange e 8	pecies o species abitat known to occu wit in a ea
Falcunculus f ontatus w itei		
C este S ike-tit (no t e n), No t e n S ike-tit 8 [26013] 8	Vulne able 8	Species o species abitat 8 likely to occu wit in a ea
Rost atula aust alis 8		
Aust alian Painte -snipe, Aust alian Painte Snipe [77037]	En ange e 8	pecies o species abitat 8 may occu wit in a ea
yto novae ollan iae kimbe li		
Maske Owl (no t e n) [2604] 8	Vulne able 8	Species o species abitat 8 likely to occu wit in a ea
Dasyu us allucatus		
No t e n Quoll, Digul [Gogo-Yimi i], Wijinga a 8 [Dambimanga i], Wiminji [Ma tu] [331] 8	En ange e 8	pecies o species abitat may occu wit in a ea
Mac o e ma gigas		
G host Bat [174] 8	Vulne able 8	Species o species abitat likely to occu wit in a ea
Mac otis lagotis		
G reate Bilby [2 2] 8	Vulne able 8	Species o species abitat likely to occu wit in a ea
Pseu antec inus mimulus		
Ca penta ian Antec inus [592 3] 8	Vulne able 8	Species o species abitat known to occu wit in a ea
Saccolaimus saccolaimus nu icluniatus		
Ba e- umpe S eat -taile Bat, Ba e- umpe 8 S eat tail Bat [66 9] 8	Vulne able 8	Species o species abitat 8 may occu wit in a ea 8
Reptiles		
Elseya lava acko um		
Gulf Snapping u tle [67197] 8	En ange e 8	pecies o species abitat 8 may occu wit in a ea

Listed Mi t Species A

_pus p cificus
F k-t iled Swift [678] A
Species species h bit t likel t ccu within e

Mi t Te est i l Species

Cec pis d u ic A
Red- umped Sw ll w [80610] A
Species species h bit t m a ccu within e

Cuculus pt tus
O rient l Cuck , H sfield's Cuck [86651] A
Species species h bit t m a ccu within e

Hi und ustic
B n Sw ll w [662] A
Species species h bit t m a ccu within e

M ot cill cine e
G e Wa t il [642] A
Species species h bit t m a ccu within e

M ot cill fl v A
Yell w Wa t il [644] A
Species species h bit t m a ccu within e

Mi t Wetl nds Species A

_ctitis h p leuc s
C mmon S ndpipe [59309] A
Species species h bit t m a ccu within e

C lid is cumin t
Sh p-t iled S ndpipe [874] A
Species species h bit t m a ccu within e

C lid is fe u ine
Cu lew S ndpipe [856] A
C itic ll End n e ed
Species species h bit t m a ccu within e

C lid is mel n t s
Pect l S ndpipe [858] A
Species species h bit t m a ccu within e

Ch d ius ve edus A
O rient l Pl ve , O ient l D tte el [882] A
Species species h bit t m a ccu within e

Gl e l m aldiv um
O rient l P tinc le [840] A
Species species h bit t m a ccu within e

P ndi n h li etus A
Osp e [952] A
Species species h bit t m a ccu within e

Othe M atte s P otected by the EPBC ct T

e M a e es

* ecies is listed u de diffe e t scie tific me o the EPBC Act - h e te ed ecies list.

me T	h e te ed T	y e of P ese ce
Bi ds		
Actitis hy oleucos Commo d i e [59309] S T		ecies o s ecies h bitTt may occu withi e
A se s semi lm at T M ag ie Goose [978] S		ecies o s ecies h bit t T may occu withi e T
A us cificus T Fo k-t iled wift [678] S T		ecies o s ecies h bit t likely to occu withi e
A de lb G e t Eg et, White Eg et [59541] S T		ecies o s ecies h bit t likely to occu withi e
A de ibis C ttle Eg et [59542] S T		ecies o s ecies h bit t T may occu withi e
C lid is cumi t h -t iled d i e [874] S T		ecies o s ecies h bit t T may occu withi e
C lid is fe ugi e Cu lew d i e [856] T	C itic lly E d ge ed S	ecies o s ecies h bit t may occu withi e
C lid is mel otos Pecto l d i e [858] S T		ecies o s ecies h bit t may occu withi e
Ch d ius ve edus O ie t l Plove , O ie t l Dotte el [882] S T		ecies o s ecies h bit t may occu withi e
Ch ysococcyx oscul s Bl ck-e ed Cuckoo [705] S T		ecies o s ecies h bit t may occu withi e
Gl eol m aldiv um O ie t l P ti cole [840] S T		ecies o s ecies h bit t may occu withi e
H li eetus leucog ste White-bellied e -E gle [943] S T		ecies o s ecies h bit t likely to occu withi e
Hi u do d u ic Red- um ped w llow [59480] S T		ecies o s ecies h bit t may occu withi e
Hi u do ustic B w llow [662] S T		ecies o s ecies h bit t may occu withi e
Me o s o tus R i bow Bee-e te [670] S T		ecies o s ecies h bit t may occu withi e
Mot cill ci e e T G ey Wagt il [642] S T		ecies o s ecies h bit t T may occu withi

Name	Threate e M	T e of Prese ce
		area
tacilla flava Yellow Wagtail [644]		S ecies or s ecies habitat ma occur withi area
Pa io haliaetus Os re [952]		S ecies or s ecies habitat ma occur withi area
Rostratula be ghale sis (se su lato) M Pai te S i e [889] M	E a gere *	S ecies or s ecies habitat ma occur withi area
Re tiles		
Croco lus joh sto i Freshwater Croco ile, Joh sto 's Croco ile, M Joh sto 's River Croco ile [1773]		S ecies or s ecies habitat M ma occur withi area

Ext a I formatio

I vasive S ecies [Resource I formatio]

Wee s that are co si ere to be the 20 s ecies of atio al sig ifica ce (WoNS), alo g with other i tro uce la ts that are co si ere to be the States a Territories to ose a articularl sig ifica t threat to bio iversit . The followi g feral a imals are re orte : Goat, Re Fox, Cat, Rabbit, Pig, Water Buffalo a Ca e Toa . M s from La sca e Health Project, Natio al La a Water Resources Au it, 2001.

Name M	Status M	T e of Prese ce
Bir s		
Passer omesticus M House S arrow [405] M		S ecies or s ecies habitat likel to occur withi area
Rhi ella mari a M Ca e Toa [83218] M		S ecies or s ecies habitat likel to occur withi area
Bos taurus Domestic Cattle [16]		S ecies or s ecies habitat likel to occur withi area
Bubalus bubalis M Water Buffalo, Swam p Buffalo [1] M		S ecies or s ecies habitat likel to occur withi area
Ca is lu us familiaris M Domestic Dog [82654] M		S ecies or s ecies habitat likel to occur withi area
Equus asinus M Do ke , Ass [4] M		S ecies or s ecies habitat likel to occur withi area
Equus caballus M Horse [5] M		S ecies or s ecies habitat M likel to occur withi area

Name w	Status w	e f Presence
Fe is catus Cat, H use Cat, D mestic Cat [19] w		S ecies r s ecies habitat likel t ccur ithin area
Sus scr fa w Pig [6]		S ecies r s ecies habitat likel t ccur ithin area
Plants		
Acacia nil tica subs . indica Prickl Acacia [6196] w		S ecies r s ecies habitat ma ccur ithin area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213] w		S ecies r s ecies habitat w likel t ccur ithin area

C ve t

The nformat on pre ente n th report h een prov e y r nge of t ource cknowle ge t the en of the report.

Th report e gne to t n ent fy ng the loc t on of pl ce wh ch may e relev nt n eterm n ng o l g t on un er the Env ronment Protect on n B o ver ty Con erv t on Act 1999. It hol mappe loc t on of Worl n N t on l Her t ge propert e , Wetl n of Intern t on l n N t on l Import nce, Commonwe lth n St te/Terr tory re erve , l te thre tene , migr tory n mar ne pec e n l te thre tene ecolog c l commun t e . Mapp ng of Commonwe lth l n not complete t th t ge. Map h ve een coll te from r nge of ource t v r ou re olut on .

Not ll pec e l te un er the EPBC Act h ve een mappe (ee elow n therefore report gener l gu e only. Where v l le t upport mapp ng, the type of pre ence th t c n e eterm ne from the t n c te n gener l terms. People u ng th nformat on n mak ng referr l may nee to con er the qu l f c t on elow n may nee to eek n con er other nformat on ource .

For thre tene ecolog c l commun t e where the tr ut on well known, map re er ve from recovery pl n , St te veget t on map , remote en ng magery n other ource . Where thre tene ecolog c l commun ty tr ut on re le well known, ex t ng veget t on map n po nt loc t on t re u e to pro uce n c t ve tr ut on map .

Thre tene , migr tory n mar ne pec e tr ut on h ve een er ve through v r ety of metho . Where tr ut on re well known n f t me permi t , map re er ve u ng e ther themat c p t l t (.e. veget t on, o l , geology, elev t on, pect, terr n, etc together w th po nt loc t on n e cr e h t t; or env ronment l mo ell ng (MAXENT or BIOCLIM h t t mo ell ng u ng po nt loc t on n env ronment l t l yer .

Where very l ttle nformat on v l le for pec e or l rge number of map re requ re n hort t me-fr me, map re er ve e ther from 0.04 or 0.02 ec mal egree cell ; y n utomate proce u ng polygon c pture techn que (t t c two k lometre gr cell , lph -hull n convex hull ; or c pture manu lly or y u ng topogr ph c fe ture (n t on l p rk oun re , l n , etc . In the e rly t ge of the tr ut on mapp ng proce (1999-e rly 2000 tr ut on were ef ne y egree lock , 100K or 250K map heet to r p ly cre te tr ut on m p . More rel le tr ut on mapp ng metho re u e to up te the e tr ut on t me permi t .

Only electe pec e covere y the follow ng prov on of the EPBC Act h ve een mappe :

- migr tory n
- mar ne

The follow ng pec e n ecolog c l commun t e h ve not een mappe n o not ppe r n report pro uce from th t e:

- thre tene pec e l te ext nct or con ere v gr nt
- ome pec e n ecolog c l commun t e th t h ve only recently een l te
- ome terre tr l pec e th t overfly the Commonwe lth mar ne re
- migr tory pec e th t re very w e pre , v gr nt, or only occur n mall number

The follow ng group h ve een mappe , ut may not cover the complete tr ut on of the pec e :

- non-thre tene e r wh ch h ve only een mappe for recor e ree ng te
- e l wh ch h ve only een mappe for ree ng te ne r the Au tr l n cont nent

Such ree ng te may e mport nt for the protect on of the Commonwe lth Mar ne env ronment.

Coor n te

-16.477111 134.597816,-16.282944 134.597816,-16.282944 134.863795,-16.686305 134.859469,-16.475715 134.599258,-16.475715 134.599258,-16.477111 134.597816)

Ac no l g men s w

This b s h s b n compil from r ng of sourc s. Th p r men c no l g s h follo ing w cus o i ns ho h v con ribu v lu bl n vic :

-Offic of Environmen n H ri g , N Sou h Wal s
-D p r men of Environmen n Primary In us ri s, Vic ori
-D p r men of Primary In us ri s, P rks, Wa r n Environmen , T sm ani
-D p r men of Environmen , Wa r n N ur l R sourc s, Sou h Aus r li
-D p r men of L n n R sourc Man g men , Nor h rn T rri ory
-D p r men of Environmen l n H ri g Pro c ion, Qu nsl n
-D p r men of P rks n Wil lif , Wes rn Aus r li
-Environmen n Pl nning Dir c or , ACT
-Bir lif Aus r li
-Aus r li n Bir n B B n ing Sch me w
-Aus r li n N ion l Wil lif Coll c ion
-N ur l his ory mus ums of Aus r li
-Mus um Vic ori
-Aus r li n Mus um
-Sou h Aus r li n Mus um
-Qu nsl n Mus um
-Onlin Zoologic l Coll c ions of Aus r li n Mus ums w
-Qu nsl n H rb rium
-N ion l H rb rium of NSW
-Roy l Bo nic G ar ns n N ion l H rb rium of Vic ori
-T sm ani n H rb rium
-S H rb rium of Sou h Aus r li
-Nor h rn T rri ory H rb rium
-Wes rn Aus r li n H rb rium
-Aus r li n N ion l H rb rium, C nb rr
-Univ rsi y of N Engl n
-Oc n Biog ogr phic Informa ion Sys m
-Aus r li n Gov rnmen , D p r men of D f nc
For s ry Corpor ion, NSW
-G osci nc Aus r li
-CSIRO
-Aus r li n Tropic l H rb rium, C irns w
- Bir Aus r li
-Aus r li n Gov rnmen – Aus r li n An rc ic D C n r
-Mus um n Ar G al ry of h Nor h rn T rri ory
-Aus r li n Gov rnmen N ion l Environmen l Sci nc Progr m
-Aus r li n Ins i u of Marin Sci nc
-R f Lif Surv y Aus r li
-Amer ic n Mus um of N ur l His ory
-Qu n Vic ori Mus um n Ar G al ry, Inv r sk, T sm ani w
-T sm ani n Mus um n Ar G al ry, Hob r , T sm ani
-O h r groups n in ivi u ls

Th D p r men is x r mely gr ful o h many org nis ions n in ivi u ls ho provi xp r vic w n inform a ion on num erous r f is ribu ions.

Pl s f l fr o provi f b ck vi h Con c Us p g .

D p r men of h Environmen w
GPO Box 787
C nb rr ACT 2601 Aus r li
+61 2 6274 1111

Appendix B: Natural Resource Management Report

Territory Natural Resource Management

Northern Territory Government

CHARLES DARWIN UNIVERSITY

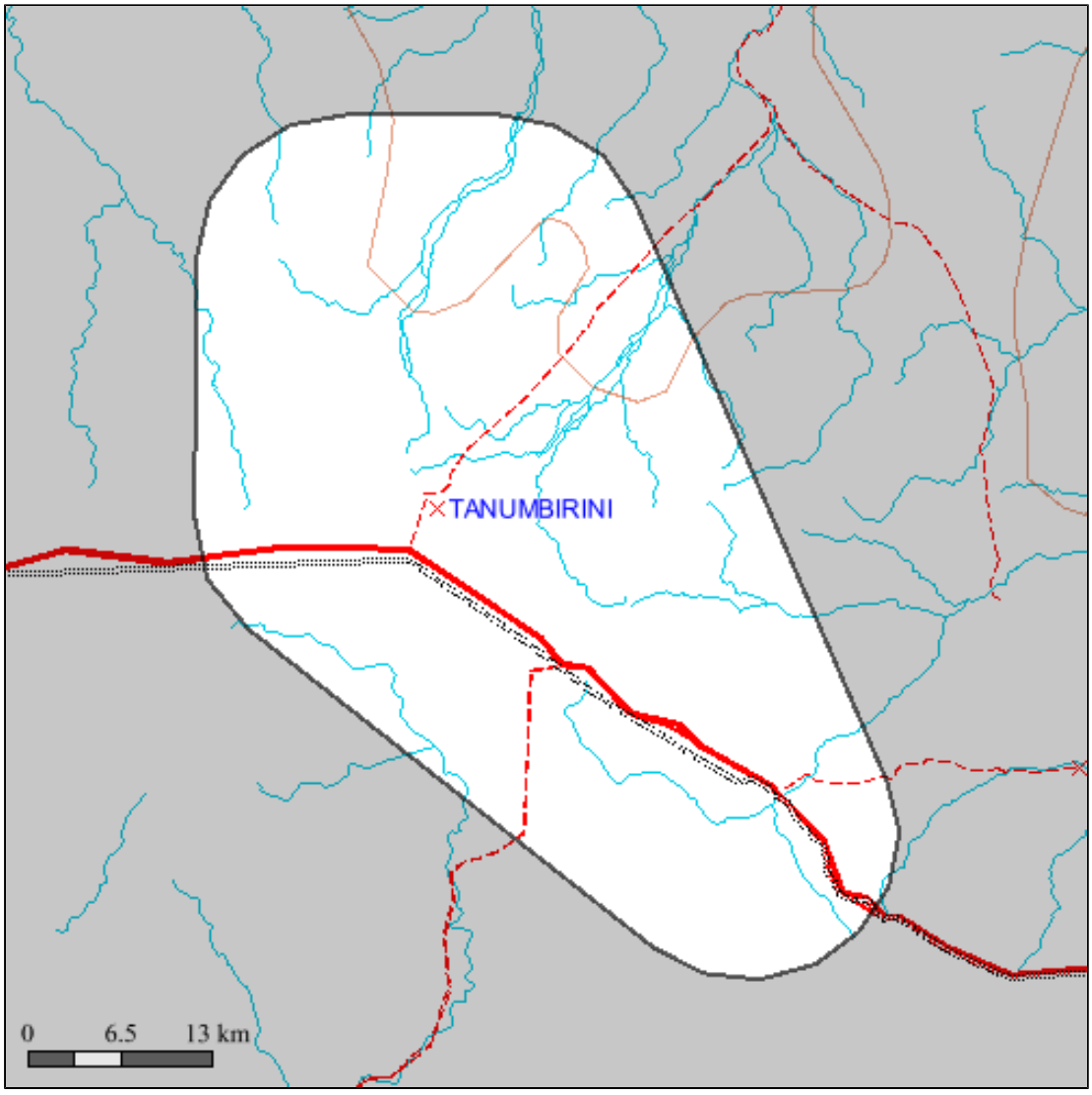
Custom area

NT NRM Report

Custom area

Custom area encompasses an area of 1807.39 sq km extending from 16 deg 12.0 min to 16 deg 45.0 min S and 134 deg 29.0 min to 134 deg 56.0 min E.
Custom area is located in the Gulf Fall and Uplands, Sturt Plateau, bioregion(s)

Location of Custom area

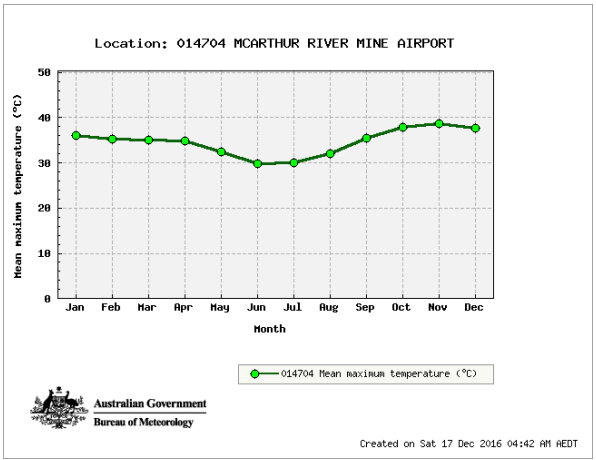


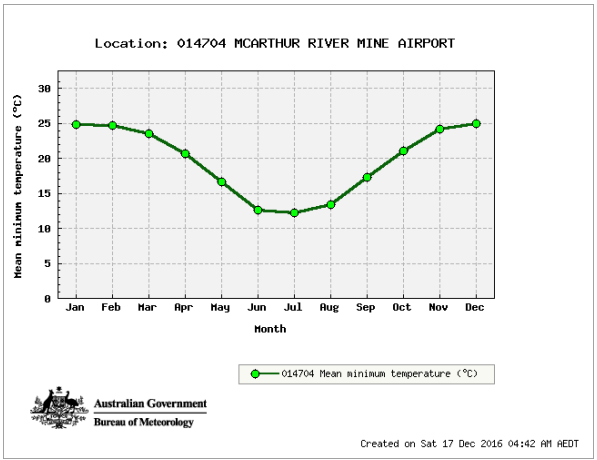
Custom area Climate

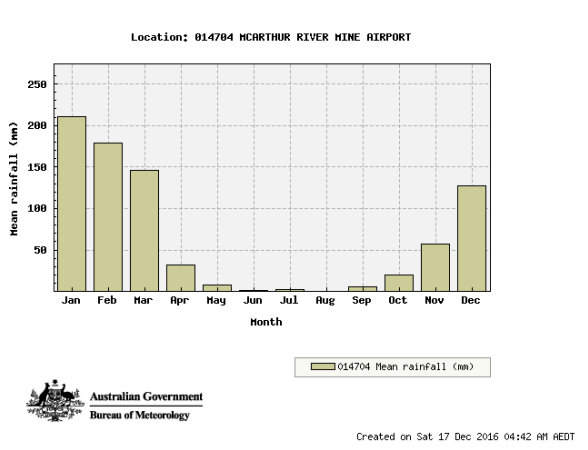
The closest long-term weather station is MCARTHUR RIVER MINE (16 deg 26.0 min S, 136.076E) 145 km E of the center of selected area

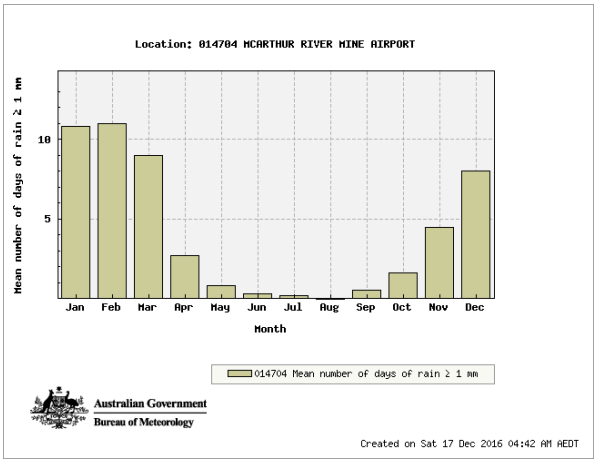
Statistics	Annual Values	Years of record
Mean max temp (deg C)	34.6	39
Mean min temp (deg C)	19.7	39
Average rainfall (mm)	766.1	38
Average days of rain	49.4	45

Climate summaries from Bureau of Meteorology (www.bom.gov.au)



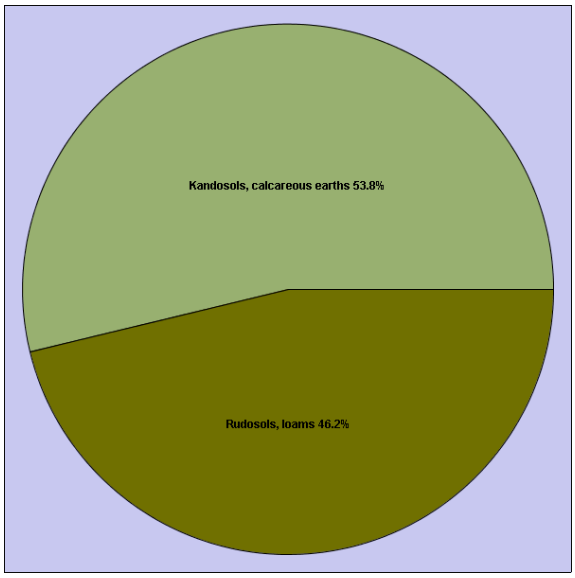






Custom area Soils

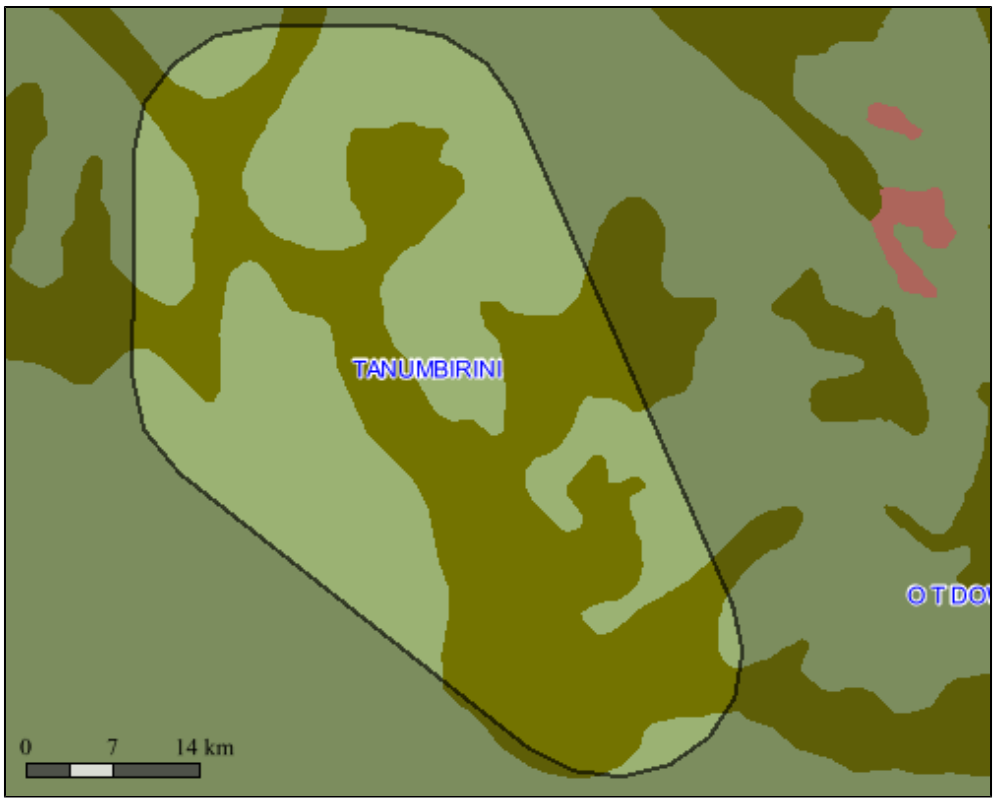
Soil Types



Area of soil types (Northcote Factual Key)

Category	Area sq km	Area%
Kandosols, calcareous earths	972.43	53.80
Rudosols, loams	834.96	46.20

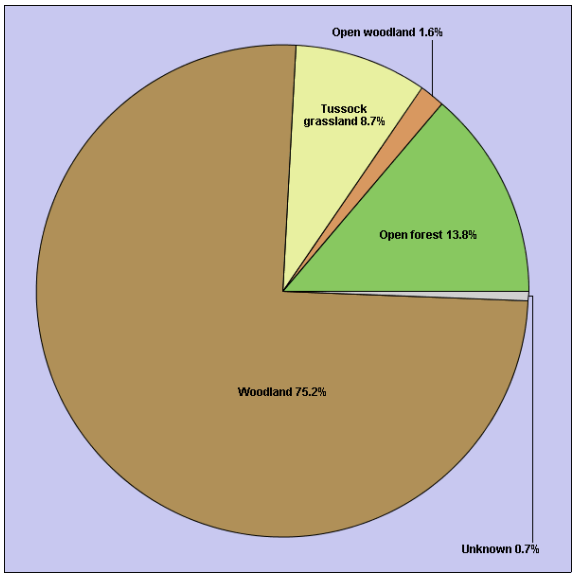
Soil Types



Soils 1:2M Layer is a copy of the NT portion (1:2,000,000 scale dataset) of the CSIRO Atlas of Australian Soils - K.H. Northcote et al. Data scale: 1:2,000,000 ANZLIC Identifier: 2DBCB771205D06B6E040CD9B0F274EFE
More details: Go to www.lrm.nt.gov.au/nrmapsnt/ and enter the ANZLIC identifier in the Spatial Data Search

Custom area Vegetation

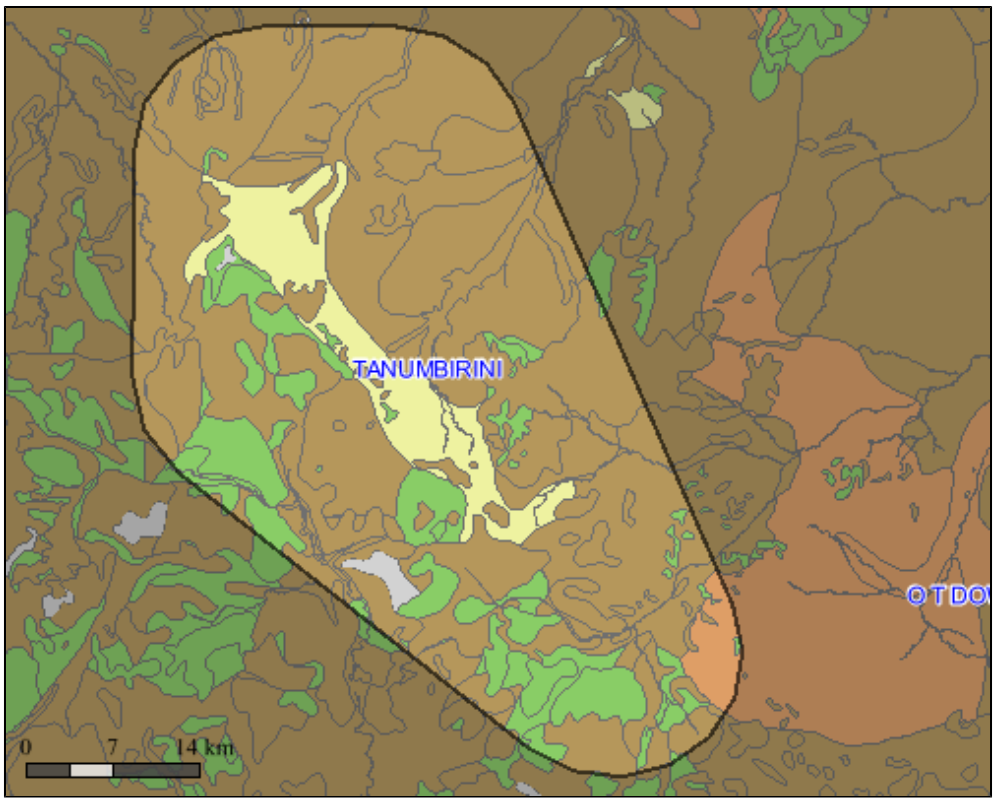
Vegetation Communities



Area of vegetation communities

Category	Area sq km	Area%
Woodland	1359.29	75.21
Open forest	248.56	13.75
Tussock grassland	158.11	8.75
Open woodland	29.57	1.64
Unknown	11.86	.66

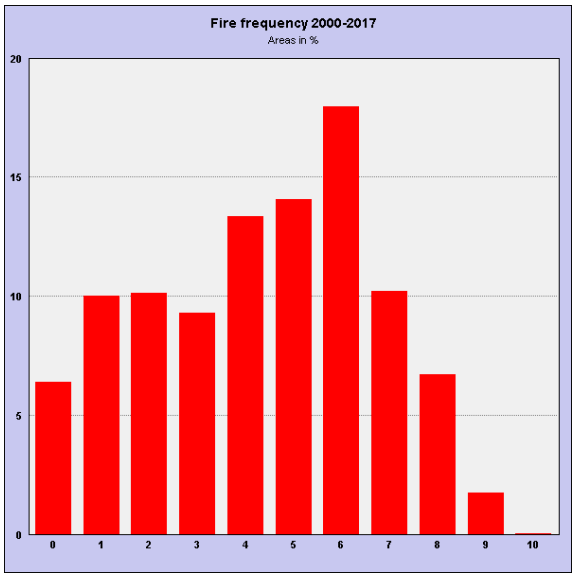
Vegetation Communities



The NVIS 2005 Layer is compiled from a number of vegetation and land unit survey maps that were recoded and re-attributed for the National Vegetation Information System (NVIS)
Data scale variable depending on location. ANZLIC Identifier:2DBCB771207006B6E040CD9B0F274EFE
More details:Go to www.lrm.nt.gov.au/nrmapsnt/ and enter the ANZLIC identifier in the Spatial Data Search

Custom area Fire History

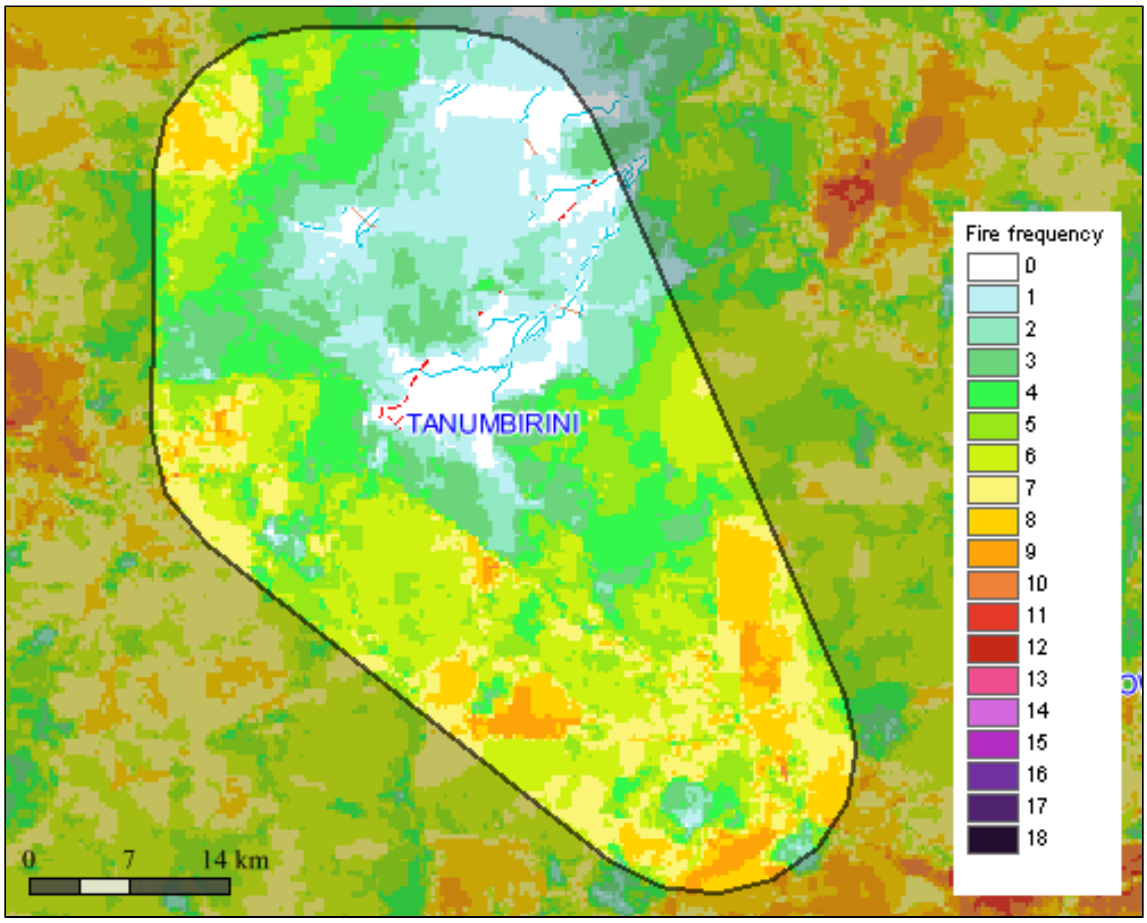
Fire frequency 2000-2017



area burnt for each fire frequency category 2000-2017

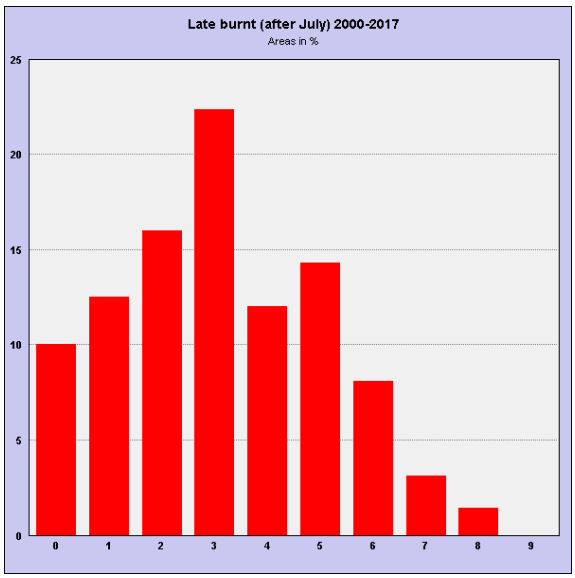
Category	Area sq km	Area%
0	115.48	6.39
1	181.34	10.03
2	183.18	10.13
3	168.48	9.32
4	241.17	13.34
5	254.24	14.07
6	324.74	17.97
7	184.99	10.24
8	121.51	6.72
9	31.52	1.74
10	.75	.04

Fire frequency 2000-2017



The fire frequency(250m) Layer is derived from satellite imagery sourced from the Moderate Resolution Imaging Spectroradiometer (MODIS) on the NASA Terra satellite
Spatial Resolution: 250m x 250m pixels (at Nadir).

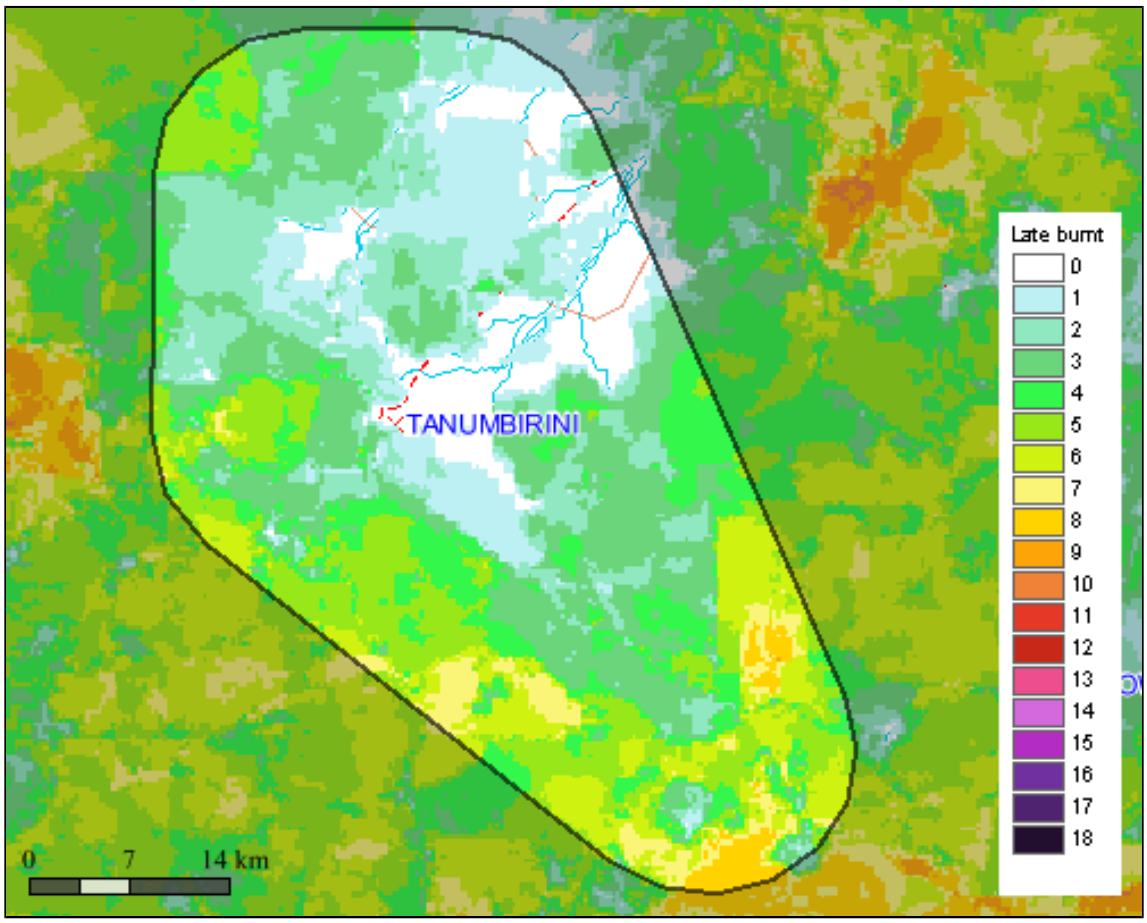
Late fire frequency(after July 31) 2000-2017



area burnt in each late fire frequency category 2000-2017

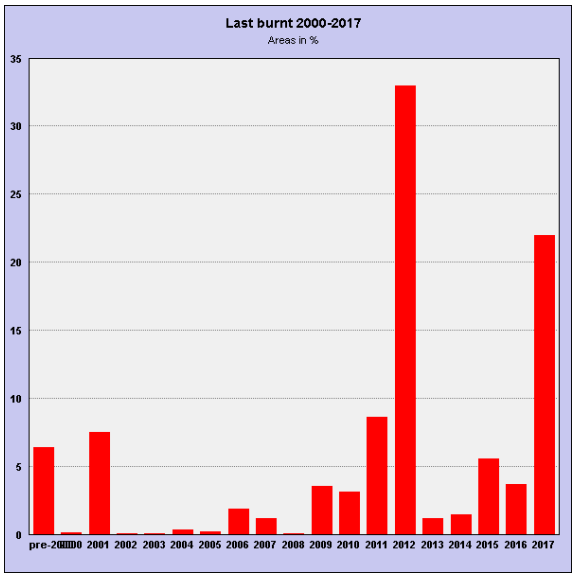
Category	Area sq km	Area%
0	181.75	10.06
1	226.39	12.53
2	289.26	16.00
3	403.91	22.35
4	217.82	12.05
5	259.01	14.33
6	146.42	8.10
7	56.96	3.15
8	25.71	1.42
9	.15	.01

Late fire frequency 2000-2017



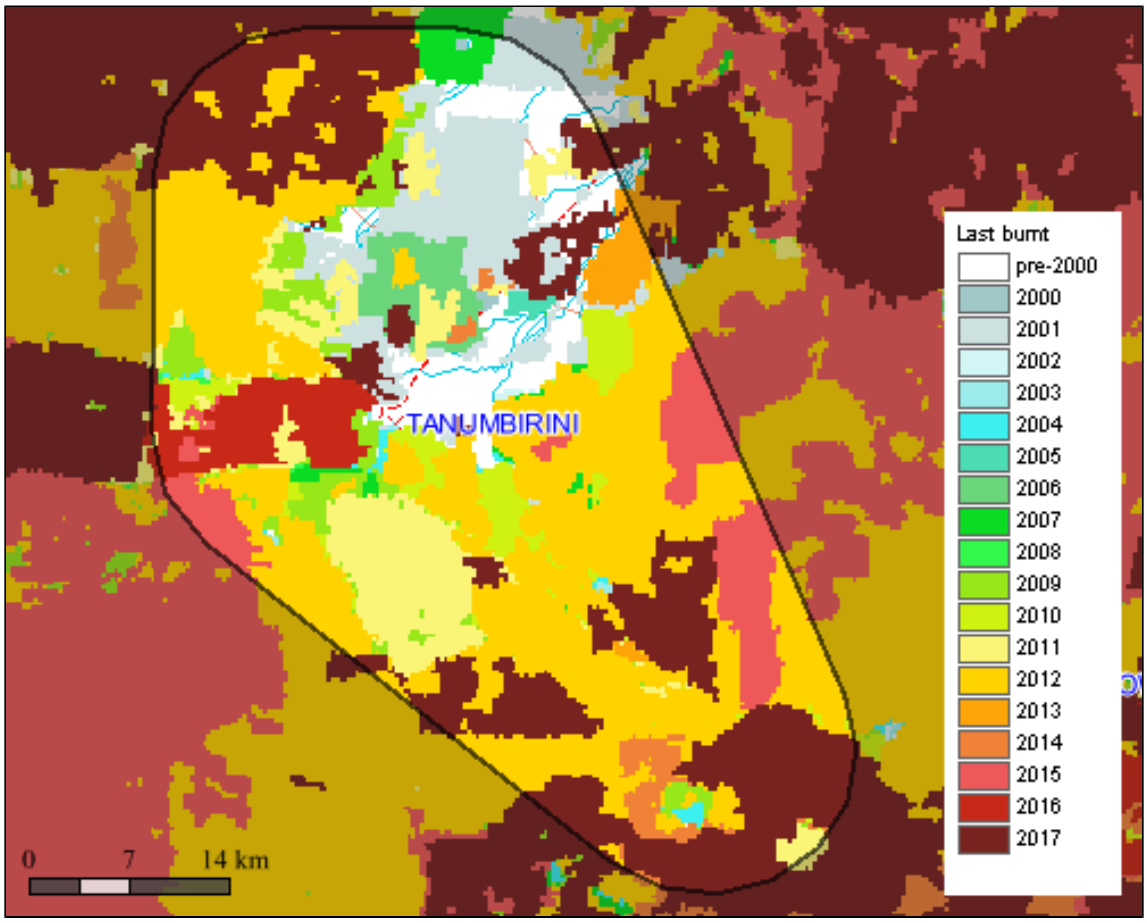
The fire frequency(250m) Layer is derived from satellite imagery sourced from the Moderate Resolution Imaging Spectroradiometer (MODIS) on the NASA Terra satellite
Spatial Resolution: 250m x 250m pixels (at Nadir).

Year last burnt 2000-2017 and area of each year category



Category	Area sq km	Area%
pre-2000	115.48	6.39
2000	1.95	.11
2001	135.29	7.49
2002	1.42	.08
2003	1.42	.08
2004	6.29	.35
2005	4.12	.23
2006	34.31	1.90
2007	21.27	1.18
2008	.90	.05
2009	64.00	3.54
2010	56.25	3.11
2011	155.80	8.62
2012	596.58	33.01
2013	20.99	1.16
2014	26.46	1.46
2015	100.15	5.54
2016	67.19	3.72
2017	397.51	21.99

Year last burnt 2000-2017



The fire frequency(250m) Layer is derived from satellite imagery sourced from the Moderate Resolution Imaging Spectroradiometer (MODIS) on the NASA Terra satellite Spatial Resolution: 250m x 250m pixels (at Nadir).

Custom area Threatened Species

Threatened species recorded in Custom area (Records Updated: Sept 2013)

Group	Common Name	Scientific Name	NT Status	National Status	ID	#Observations (Latest)	#Specimens (Latest)	#Surveys (Latest)
Reptiles	Mertens` Water Monitor	*Varanus mertensi*	VU	.	347295	2 (1993)	0 (Unknown)	1 (1993)
Mammals	Carpentarian Antechinus	*Pseudantechinus mimulus*	.	VU	176925	0 (Unknown)	1 (1987)	0 (Unknown)

EX = Extinct
EW = Extinct in the Wild
ER = Extinct in the NT
EN = Endangered
EN/VU = One Endangered subspecies/One Vulnerable subspecies
VU=Vulnerable
VU/- = One or more subspecies vulnerable EN/- = One or more subspecies endangered

Survey = this category refers to data collected using systematic survey methodology
Specimen = this category refers to museum or other records where a specimen has been collected and lodged
Observation = this category refers to all other incidental recordings where systematic methodology may not have been used consistently.

More species info: Go to www.landmanager.org.au/view/index.aspx?id=####
where #### is the ID number from the tables above for the species of interest.

Custom area Threatened Species Grid

Threatened species recorded in the grid cell(s) in which Custom area occurs (Records Updated: Sept 2013)

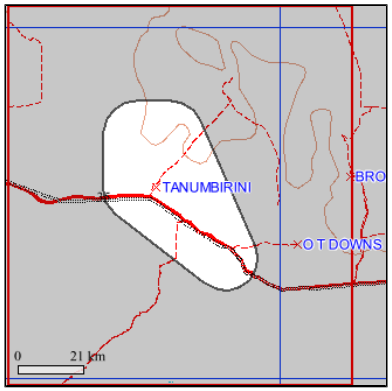
Group	Family Name	Scientific Name	Common Name	NT Status	National Status	#Observations	Latest Observation Date	#Specimens	Latest Specimen Date	#Surveys	Latest Survey Record
Reptiles	Varanidae	*Varanus mertensi*	Mertens` Water Monitor	VU		3	1993	0	Unknown	1	1993
Mammals	Dasyuridae	*Pseudantechinus mimulus*	Carpentarian Antechinus		VU	0	Unknown	1	1987	0	Unknown

EX = Extinct
EW = Extinct in the Wild
ER = Extinct in the NT
EN = Endangered
EN/VU = One Endangered subspecies/One Vulnerable subspecies
VU=Vulnerable
VU/- = One or more subspecies vulnerable EN/- = One or more subspecies endangered

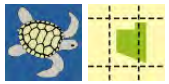
Survey = this category refers to data collected using systematic survey methodology
Specimen = this category refers to museum or other records where a specimen has been collected and lodged
Observation = this category refers to all other incidental recordings where systematic methodology may not have been used consistently.

More species info: Go to www.landmanager.org.au/view/index.aspx?id=####
where #### is the ID number from the tables above for the species of interest.

Species listed in the table above were recorded from all the grid cells shown below (red/blue line) that overlap Custom area



Custom area Native Species



Native species that have been recorded in the grid cell(s) in which Custom area occurs

Group	Family Name	Scientific Name	Common Name	NT Status	National Status	#Observations	#Latest Observation Date	#Specimens	#Latest Speciman Date	#Surveys	#Latest Survey Record
Ferns	Lygodiaceae	*Lygodium microphyllum*	Climbing Maidenhair Fern			0	Unknown	2	1977	0	Unknown
Ferns	Marsileaceae	*Marsilea angustifolia*	Narrow-leaf Nardoo			0	Unknown	4	1977	0	Unknown
Ferns	Lindsaeaceae	*Lindsaea brachypoda*	Wedgefern			0	Unknown	2	1977	0	Unknown
Ferns	Lindsaeaceae	*Lindsaea ensifolia*	Common Wedgefern			0	Unknown	2	1977	0	Unknown
Ferns	Pteridaceae	*Cheilanthes brownii*	Northern Rock-fern			0	Unknown	2	1977	0	Unknown
Ferns	Pteridaceae	*Cheilanthes nudiuscula*	Fern			0	Unknown	10	1989	0	Unknown
Ferns	Pteridaceae	*Cheilanthes pumilio*	Fern			0	Unknown	2	1967	0	Unknown
Ferns	Pteridaceae	*Cheilanthes tenuifolia*	Rock Fern			0	Unknown	2	2001	0	Unknown
Flowering Plants	Lauraceae	*Cassytha filiformis*	Hairy Dodder-laurel			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Hernandiaceae	*Gyrocarpus americanus*	Stinkwood			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Alismataceae	*Caldesia oligococca var. oligococca*	Caldesia			0	Unknown	2	1994	0	Unknown
Flowering Plants	Hydrocharitaceae	*Vallisneria rubra*	Eel Grass			0	Unknown	2	1994	0	Unknown
Flowering Plants	Colchicaceae	*Iphigenia indica*	Iphigenia			0	Unknown	1	1989	0	Unknown
Flowering Plants	Eriocaulaceae	*Eriocaulon carpentariae*	Hatpins	DD		0	Unknown	4	1994	0	Unknown
Flowering Plants	Eriocaulaceae	*Eriocaulon cinereum*	Hatpins			0	Unknown	2	1993	0	Unknown
Flowering Plants	Cyperaceae	*Bulbostylis barbata*	Short-leaved Rush			0	Unknown	4	1983	0	Unknown
Flowering Plants	Cyperaceae	*Cyperus astartodes*	Sedge			0	Unknown	4	1983	0	Unknown
Flowering Plants	Cyperaceae	*Cyperus betchei*	Sedge			0	Unknown	2	1983	0	Unknown
Flowering Plants	Cyperaceae	*Cyperus betchei subsp. commiscens*	Sedge			0	Unknown	2	1977	0	Unknown
Flowering Plants	Cyperaceae	*Cyperus carinatus*	Sedge			0	Unknown	4	1988	0	Unknown
Flowering Plants	Cyperaceae	*Cyperus castaneus*	Sedge			0	Unknown	2	1977	0	Unknown
Flowering Plants	Cyperaceae	*Cyperus concinnus*	Trim Sedge			0	Unknown	2	1991	0	Unknown
Flowering Plants	Cyperaceae	*Cyperus crispulus*	Sedge			0	Unknown	4	1987	0	Unknown
Flowering Plants	Cyperaceae	*Cyperus cristulatus*	Sedge			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Cyperaceae	*Cyperus cunninghamii subsp. uniflorus*	Sedge			0	Unknown	2	1983	0	Unknown
Flowering Plants	Cyperaceae	*Cyperus dactylotes*	Sedge			0	Unknown	3	1988	0	Unknown
Flowering Plants	Cyperaceae	*Cyperus eleusinoides*	Sedge			0	Unknown	2	1986	0	Unknown
Flowering Plants	Cyperaceae	*Cyperus exaltatus*	Giant Sedge			0	Unknown	2	1986	0	Unknown
Flowering Plants	Cyperaceae	*Cyperus fucosus*	Sedge	DD		0	Unknown	2	1947	0	Unknown
Flowering Plants	Cyperaceae	*Cyperus holoschoenus*	Umbrella Rush			0	Unknown	8	1986	0	Unknown
Flowering Plants	Cyperaceae	*Cyperus iria*	Rice Flat Sedge			0	Unknown	1	1983	0	Unknown
Flowering Plants	Cyperaceae	*Cyperus javanicus*	Saw Rush			0	Unknown	2	1977	0	Unknown
Flowering Plants	Cyperaceae	*Cyperus macrostachyos*	Tick Grass			0	Unknown	6	1995	0	Unknown
Flowering Plants	Cyperaceae	*Cyperus microcephalus*	Sedge			0	Unknown	4	1977	0	Unknown
Flowering Plants	Cyperaceae	*Cyperus oxycarpus*	Sedge	DD		0	Unknown	2	1977	0	Unknown

Group	Family Name	Scientific Name	Common Name	NT Status	National Status	#Observations	#Latest Observation Date	#Specimens	#Latest Speciman Date	#Surveys	#Latest Survey Record
Flowering Plants	Cyperaceae	*Cyperus polystachyos*	Bunchy Sedge			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Cyperaceae	*Cyperus pulchellus*	White Button Sedge			0	Unknown	2	1983	0	Unknown
Flowering Plants	Cyperaceae	*Cyperus sexflorus*	Sedge			0	Unknown	2	1983	0	Unknown
Flowering Plants	Cyperaceae	*Cyperus squarrosus*	Bearded Flatsedge			0	Unknown	2	1977	0	Unknown
Flowering Plants	Cyperaceae	*Cyperus tenuispica*	Pink-root Sedge			0	Unknown	4	1983	0	Unknown
Flowering Plants	Cyperaceae	*Eleocharis pallens*	Pale Spike-Rush			0	Unknown	1	1994	0	Unknown
Flowering Plants	Cyperaceae	*Eleocharis triquetra*	Spike-Rush			0	Unknown	4	1994	0	Unknown
Flowering Plants	Cyperaceae	*Fimbristylis acuminata*	Fringe-Rush			0	Unknown	1	1947	0	Unknown
Flowering Plants	Cyperaceae	*Fimbristylis bisumbellata*	Fringe-Rush	DD		0	Unknown	2	1988	0	Unknown
Flowering Plants	Cyperaceae	*Fimbristylis caespitosa*	Fringe-Rush			0	Unknown	2	Unknown	0	Unknown
Flowering Plants	Cyperaceae	*Fimbristylis cardiocarpa*	Fringe-Rush			0	Unknown	2	1977	0	Unknown
Flowering Plants	Cyperaceae	*Fimbristylis corynocarya*	Fringe-Rush	DD		0	Unknown	2	2001	0	Unknown
Flowering Plants	Cyperaceae	*Fimbristylis costiglumis*	Fringe-Rush			0	Unknown	2	1983	0	Unknown
Flowering Plants	Cyperaceae	*Fimbristylis depauperata*	Fringe-Rush			0	Unknown	2	1971	0	Unknown
Flowering Plants	Cyperaceae	*Fimbristylis dichotoma*	Eight Day Grass			0	Unknown	2	1988	0	Unknown
Flowering Plants	Cyperaceae	*Fimbristylis ferruginea*	Fringe-Rush			0	Unknown	2	1987	0	Unknown
Flowering Plants	Cyperaceae	*Fimbristylis laxiglumis*	Fringe-Rush			0	Unknown	2	1947	0	Unknown
Flowering Plants	Cyperaceae	*Fimbristylis littoralis*	Fringe-Rush			0	Unknown	6	1988	0	Unknown
Flowering Plants	Cyperaceae	*Fimbristylis littoralis var. littoralis*	Fringe-Rush			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Cyperaceae	*Fimbristylis microcarya*	Fringe-Rush			0	Unknown	2	1991	0	Unknown
Flowering Plants	Cyperaceae	*Fimbristylis oxystachya*	Iukarrara			0	Unknown	2	1987	0	Unknown
Flowering Plants	Cyperaceae	*Fimbristylis phaeoleuca*	Water Grass			0	Unknown	3	1988	0	Unknown
Flowering Plants	Cyperaceae	*Fimbristylis rupestris*	Fringe-Rush			0	Unknown	2	1977	0	Unknown
Flowering Plants	Cyperaceae	*Fimbristylis schultzii*	Fringe-Rush			0	Unknown	2	1977	0	Unknown
Flowering Plants	Cyperaceae	*Fimbristylis sphaerocephala*	Fringe-Rush			0	Unknown	4	1977	0	Unknown
Flowering Plants	Cyperaceae	*Fimbristylis squarrulosa*	Fringe-Rush			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Cyperaceae	*Fimbristylis trigastrocarya*	Fringe-Rush			0	Unknown	2	1977	0	Unknown
Flowering Plants	Cyperaceae	*Fimbristylis tristachya*	Fringe-Rush			0	Unknown	2	1977	0	Unknown
Flowering Plants	Cyperaceae	*Rhynchospora exserta*	Star Sedge			0	Unknown	2	1976	0	Unknown
Flowering Plants	Cyperaceae	*Rhynchospora longisetis*	Tick Grass			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Cyperaceae	*Rhynchospora subtenuifolia*	Star Sedge			0	Unknown	2	1987	0	Unknown
Flowering Plants	Cyperaceae	*Rhynchospora wightiana*	Star Sedge			0	Unknown	4	1991	0	Unknown
Flowering Plants	Cyperaceae	*Schoenoplectus laevis*	Club-Rush			0	Unknown	2	1988	0	Unknown
Flowering Plants	Cyperaceae	*Scleria brownii*	Sedge			0	Unknown	2	1987	0	Unknown
Flowering Plants	Cyperaceae	*Scleria novae-hollandiae*	Sedge			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Cyperaceae	*Scleria rugosa*	Mildrop Sedge			0	Unknown	2	1987	0	Unknown
Flowering Plants	Cyperaceae	*Scleria sphacelata*	Razor Grass			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Poaceae	*Acrachne racemosa*	Goose Grass	DD		0	Unknown	2	1991	0	Unknown
Flowering Plants	Poaceae	*Alloteropsis semialata*	Cockatoo Grass			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Poaceae	*Aristida calycina*	Dark Wiregrass			0	Unknown	4	2001	0	Unknown
Flowering Plants	Poaceae	*Aristida calycina var. calycina*	Dark Wiregrass			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Poaceae	*Aristida contorta*	Bunched Kerosene Grass			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Poaceae	*Aristida exserta*	Wire Grass			0	Unknown	2	1977	0	Unknown
Flowering Plants	Poaceae	*Aristida holathera*	Erect Kerosene Grass			0	Unknown	0	Unknown	0	Unknown

Group	Family Name	Scientific Name	Common Name	NT Status	National Status	#Observations	#Latest Observation Date	#Specimens	#Latest Speciman Date	#Surveys	#Latest Survey Record
Flowering Plants	Poaceae	*Aristida holathera var. holathera*	Erect Kerosene Grass			0	Unknown	4	1988	0	Unknown
Flowering Plants	Poaceae	*Aristida hygrometrica*	Northern Kerosene Grass			0	Unknown	3	1991	0	Unknown
Flowering Plants	Poaceae	*Aristida inaequiglumis*	Unequal Threeawn			0	Unknown	2	2008	0	Unknown
Flowering Plants	Poaceae	*Aristida ingrata*	Wire Grass			0	Unknown	2	1977	0	Unknown
Flowering Plants	Poaceae	*Aristida latifolia*	Feathertop Wiregrass			0	Unknown	4	1986	0	Unknown
Flowering Plants	Poaceae	*Aristida perniciosa*	Noxious Wiregrass	DD		0	Unknown	2	1977	0	Unknown
Flowering Plants	Poaceae	*Aristida pruinosa*	Gulf Feathertop Wiregrass			0	Unknown	2	1987	0	Unknown
Flowering Plants	Poaceae	*Aristida queenslandica var. queenslandica*	Wire Grass			0	Unknown	1	1987	0	Unknown
Flowering Plants	Poaceae	*Arundinella setosa*	Reed Grass			0	Unknown	1	1971	0	Unknown
Flowering Plants	Poaceae	*Astrebla lappacea*	Curly Mitchell Grass	DD		0	Unknown	2	1971	0	Unknown
Flowering Plants	Poaceae	*Astrebla squarrosa*	Bull Mitchell Grass			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Poaceae	*Bothriochloa bladhii*	Forest Bluegrass			0	Unknown	4	1986	0	Unknown
Flowering Plants	Poaceae	*Bothriochloa bladhii subsp. bladhii*	Forest Bluegrass			0	Unknown	2	1972	0	Unknown
Flowering Plants	Poaceae	*Brachyachne convergens*	Spider Grass			0	Unknown	2	1971	0	Unknown
Flowering Plants	Poaceae	*Brachyachne tenella*	Slender Native Couch			0	Unknown	4	1988	0	Unknown
Flowering Plants	Poaceae	*Chionachne cyathopoda*	River Grass			0	Unknown	2	1971	0	Unknown
Flowering Plants	Poaceae	*Chloris lobata*	Lobed Chloris			0	Unknown	4	1995	0	Unknown
Flowering Plants	Poaceae	*Chrysopogon fallax*	Golden-beard Grass			0	Unknown	5	1991	0	Unknown
Flowering Plants	Poaceae	*Chrysopogon pallidus*	Ribbon Grass			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Poaceae	*Cymbopogon bombycinus*	Silky Oilgrass			0	Unknown	4	1987	0	Unknown
Flowering Plants	Poaceae	*Cymbopogon procerus*	Scentgrass			0	Unknown	2	1971	0	Unknown
Flowering Plants	Poaceae	*Cymbopogon refractus*	Barbed-Wire Grass			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Poaceae	*Dichanthium fecundum*	Curly Bluegrass			0	Unknown	7	1988	0	Unknown
Flowering Plants	Poaceae	*Dichanthium sericeum*	Queensland Bluegrass			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Poaceae	*Dichanthium sericeum subsp. humilius*	Dwarf Bluegrass			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Poaceae	*Dichanthium sericeum subsp. polystachyum*	Tassel Bluegrass			0	Unknown	2	1971	0	Unknown
Flowering Plants	Poaceae	*Digitaria benthamiana*	Finger Grass	DD		0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Poaceae	*Digitaria brownii*	Cotton Panic Grass			0	Unknown	5	2001	0	Unknown
Flowering Plants	Poaceae	*Digitaria cowiei*	Finger Grass			0	Unknown	3	1991	0	Unknown
Flowering Plants	Poaceae	*Digitaria ctenantha*	Comb Finger Grass			0	Unknown	4	1991	0	Unknown
Flowering Plants	Poaceae	*Digitaria gibbosa*	Finger Grass			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Poaceae	*Digitaria longiflora*	Finger Grass			0	Unknown	2	1977	0	Unknown
Flowering Plants	Poaceae	*Digitaria nematostachya*	Finger Grass			0	Unknown	4	2001	0	Unknown
Flowering Plants	Poaceae	*Digitaria papposa*	Finger Grass			0	Unknown	2	1977	0	Unknown
Flowering Plants	Poaceae	*Ectrosia agrostoides*	Haresfoot Grass			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Poaceae	*Ectrosia leporina*	Haresfoot Grass			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Poaceae	*Ectrosia scabrida*	Haresfoot Grass			0	Unknown	2	1971	0	Unknown
Flowering Plants	Poaceae	*Elytrophorus spicatus*	Spike-grass			0	Unknown	4	1993	0	Unknown
Flowering Plants	Poaceae	*Enneapogon lindleyanus*	Wiry Nine-awn			0	Unknown	2	1971	0	Unknown
Flowering Plants	Poaceae	*Enneapogon oblongus*	Rock Nine-awn			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Poaceae	*Enneapogon pallidus*	Conetop Nine-awn			0	Unknown	2	1972	0	Unknown
Flowering Plants	Poaceae	*Enneapogon polyphyllus*	Leafy Nine-awn			0	Unknown	8	1991	0	Unknown

Group	Family Name	Scientific Name	Common Name	NT Status	National Status	#Observations	#Latest Observation Date	#Specimens	#Latest Speciman Date	#Surveys	#Latest Survey Record
Flowering Plants	Poaceae	*Enneapogon purpurascens*	Purple Nineawn			0	Unknown	2	1972	0	Unknown
Flowering Plants	Poaceae	*Enteropogon minutus*	Windmill Grass	DD		0	Unknown	2	1987	0	Unknown
Flowering Plants	Poaceae	*Eragrostis confertiflora*	Spike Lovegrass			0	Unknown	2	1991	0	Unknown
Flowering Plants	Poaceae	*Eragrostis cumingii*	Cuming`s Lovegrass			0	Unknown	10	1987	0	Unknown
Flowering Plants	Poaceae	*Eragrostis exigua*	Lovegrass			0	Unknown	4	1995	0	Unknown
Flowering Plants	Poaceae	*Eragrostis fallax*	Lovegrass			0	Unknown	6	1988	0	Unknown
Flowering Plants	Poaceae	*Eragrostis pubescens*	Giant Fairy Grass			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Poaceae	*Eragrostis schultzii*	Lovegrass			0	Unknown	2	1977	0	Unknown
Flowering Plants	Poaceae	*Eragrostis tenellula*	Delicate Lovegrass			0	Unknown	8	1988	0	Unknown
Flowering Plants	Poaceae	*Eriachne armitii*	Long-awn Wanderrie			0	Unknown	2	1971	0	Unknown
Flowering Plants	Poaceae	*Eriachne basalis*	Wanderrie Grass	DD		0	Unknown	1	1947	0	Unknown
Flowering Plants	Poaceae	*Eriachne ciliata*	Slender Wanderrie			0	Unknown	2	1987	0	Unknown
Flowering Plants	Poaceae	*Eriachne glauca*	Pan Wanderrie			0	Unknown	4	1991	0	Unknown
Flowering Plants	Poaceae	*Eriachne glauca var. glauca*	Wanderrie Grass			0	Unknown	2	1987	0	Unknown
Flowering Plants	Poaceae	*Eriachne nervosa*	Plains Wanderrie			0	Unknown	2	1977	0	Unknown
Flowering Plants	Poaceae	*Eriachne nodosa*	Wanderrie Grass			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Poaceae	*Eriachne obtusa*	Northern Wanderrie			0	Unknown	6	1988	0	Unknown
Flowering Plants	Poaceae	*Eriachne schultziana*	Salt-and-Pepper Grass			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Poaceae	*Eriochloa pseudoacrotricha*	Early Spring Grass			0	Unknown	3	1995	0	Unknown
Flowering Plants	Poaceae	*Eulalia aurea*	Silky Browntop			0	Unknown	6	1988	0	Unknown
Flowering Plants	Poaceae	*Heterachne gulliveri*	Heterachne			0	Unknown	2	1987	0	Unknown
Flowering Plants	Poaceae	*Heteropogon contortus*	Black Speargrass			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Poaceae	*Iseilema macratherum*	Bull Flinders Grass			0	Unknown	4	1987	0	Unknown
Flowering Plants	Poaceae	*Iseilema vaginiflorum*	Red Flinders Grass			0	Unknown	2	1986	0	Unknown
Flowering Plants	Poaceae	*Leptochloa neesii*	Swamp Grass			0	Unknown	4	1972	0	Unknown
Flowering Plants	Poaceae	*Lepturus xerophilus*	Lepturus	DD		0	Unknown	1	2001	0	Unknown
Flowering Plants	Poaceae	*Mnesithea formosa*	Red Grass			0	Unknown	5	1991	0	Unknown
Flowering Plants	Poaceae	*Mnesithea rottboellioides*	Northern Canegrass			0	Unknown	2	1977	0	Unknown
Flowering Plants	Poaceae	*Oryza australiensis*	Australian Wild Rice			0	Unknown	6	2002	0	Unknown
Flowering Plants	Poaceae	*Panicum decompositum*	Australian Millet			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Poaceae	*Panicum effusum*	Hairy Panic			0	Unknown	2	1987	0	Unknown
Flowering Plants	Poaceae	*Panicum laevinode*	Pepper Grass			0	Unknown	2	2002	0	Unknown
Flowering Plants	Poaceae	*Panicum latzii*	Panic	DD		0	Unknown	1	1988	0	Unknown
Flowering Plants	Poaceae	*Panicum mindanaense*	Native Panic			0	Unknown	2	1987	0	Unknown
Flowering Plants	Poaceae	*Panicum trachyrhachis*	Whistle Grass			0	Unknown	2	1991	0	Unknown
Flowering Plants	Poaceae	*Panicum trichoides*	Jungle Grass			0	Unknown	4	2001	0	Unknown
Flowering Plants	Poaceae	*Paspalidium constrictum*	Knotty-butt Paspalidium			0	Unknown	2	1987	0	Unknown
Flowering Plants	Poaceae	*Paspalidium gracile*	Slender Panic	DD		0	Unknown	6	2001	0	Unknown
Flowering Plants	Poaceae	*Paspalidium rarum*	Bunch Paspalidium			0	Unknown	6	1988	0	Unknown
Flowering Plants	Poaceae	*Paspalidium retiglume*	Paspalidium			0	Unknown	2	1971	0	Unknown
Flowering Plants	Poaceae	*Perotis rara*	Comet Grass			0	Unknown	4	1991	0	Unknown
Flowering Plants	Poaceae	*Pseudopogonatherum contortum*	Black Top			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Poaceae	*Pseudoraphis spinescens*	Spiny Mudgrass			0	Unknown	8	1991	0	Unknown
Flowering Plants	Poaceae	*Schizachyrium fragile*	Fire Grass			0	Unknown	4	1991	0	Unknown
Flowering Plants	Poaceae	*Schizachyrium pseudeulalia*	Short-leaved Silk Grass			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Poaceae	*Sehima nervosum*	White Grass			0	Unknown	2	1987	0	Unknown

Group	Family Name	Scientific Name	Common Name	NT Status	National Status	#Observations	#Latest Observation Date	#Specimens	#Latest Speciman Date	#Surveys	#Latest Survey Record
Flowering Plants	Poaceae	*Setaria apiculata*	Pigeon Grass			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Poaceae	*Setaria surgens*	Brown`s Pigeon Grass			0	Unknown	2	1991	0	Unknown
Flowering Plants	Poaceae	*Sorghum matarankense*	Sorghum			0	Unknown	4	1991	0	Unknown
Flowering Plants	Poaceae	*Sorghum plumosum*	Plume Sorghum			0	Unknown	2	1979	0	Unknown
Flowering Plants	Poaceae	*Sorghum plumosum var. plumosum*	Plume Sorghum			0	Unknown	2	1988	0	Unknown
Flowering Plants	Poaceae	*Sorghum timorense*	Downs Sorghum			0	Unknown	2	1987	0	Unknown
Flowering Plants	Poaceae	*Sporobolus australasicus*	Australian Dropseed			0	Unknown	4	1988	0	Unknown
Flowering Plants	Poaceae	*Thaumastochloa pubescens*	Thaumastochloa			0	Unknown	2	1977	0	Unknown
Flowering Plants	Poaceae	*Themeda arguens*	Annual Kangaroo Grass			0	Unknown	2	1988	0	Unknown
Flowering Plants	Poaceae	*Themeda avenacea*	Oat Kangaroo Grass			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Poaceae	*Themeda triandra*	Kangaroo Grass			0	Unknown	2	1986	0	Unknown
Flowering Plants	Poaceae	*Triodia bitextura*	Curly Spinifex			0	Unknown	8	1988	0	Unknown
Flowering Plants	Poaceae	*Triodia latzii*	Spinifex			0	Unknown	4	1988	0	Unknown
Flowering Plants	Poaceae	*Triodia microstachya*	Spinifex			0	Unknown	2	1977	0	Unknown
Flowering Plants	Poaceae	*Triodia stenostachya*	Spinifex			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Poaceae	*Tripogon loliiformis*	Five-minute Grass			0	Unknown	2	1988	0	Unknown
Flowering Plants	Poaceae	*Urochloa holosericea*	Silkytop Armgrass			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Poaceae	*Urochloa pubigera*	Armgrass Millet			0	Unknown	3	1991	0	Unknown
Flowering Plants	Poaceae	*Whiteochloa airoides*	Creeping Panic			0	Unknown	4	1988	0	Unknown
Flowering Plants	Poaceae	*Whiteochloa capillipes*	Whiteochloa			0	Unknown	4	1991	0	Unknown
Flowering Plants	Poaceae	*Yakirra australiensis*	Desert Flinders Grass			0	Unknown	2	1971	0	Unknown
Flowering Plants	Poaceae	*Yakirra majuscula*	Yakirra			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Poaceae	*Yakirra muelleri*	Yakirra	DD		0	Unknown	2	1971	0	Unknown
Flowering Plants	Poaceae	*Yakirra nulla*	Yakirra			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Poaceae	*Yakirra pauciflora*	Yakirra			0	Unknown	4	1991	0	Unknown
Flowering Plants	Commelinaceae	*Commelina agrostophylla*	Commelina			0	Unknown	2	1979	0	Unknown
Flowering Plants	Commelinaceae	*Commelina ensifolia*	Wandering Jew			0	Unknown	2	1959	0	Unknown
Flowering Plants	Commelinaceae	*Cyanotis axillaris*	Commelina			0	Unknown	2	1994	0	Unknown
Flowering Plants	Commelinaceae	*Murdannia graminea*	Pink Swamp Lily			0	Unknown	5	1989	0	Unknown
Flowering Plants	Commelinaceae	*Murdannia vaginata*	Day Flower			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Pontederiaceae	*Monochoria cyanea*	Monochoria			0	Unknown	2	1979	0	Unknown
Flowering Plants	Haemodoraceae	*Haemodorum coccineum*	Scarlet-flowered Bloodroot			0	Unknown	2	1988	0	Unknown
Flowering Plants	Menispermaceae	*Tinospora smilacina*	Snake Vine			0	Unknown	1	1988	0	Unknown
Flowering Plants	Proteaceae	*Grevillea dryandri*	Dryander`s Grevillea			0	Unknown	2	1988	0	Unknown
Flowering Plants	Proteaceae	*Grevillea heliosperma*	Rock Grevillea			0	Unknown	2	1971	0	Unknown
Flowering Plants	Proteaceae	*Grevillea parallela*	Silver Grevillea			0	Unknown	2	1987	0	Unknown
Flowering Plants	Proteaceae	*Grevillea pteridifolia*	Fern-leaved Grevillea			0	Unknown	2	1988	0	Unknown
Flowering Plants	Proteaceae	*Grevillea refracta*	Silver-leaved Grevillea			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Proteaceae	*Grevillea refracta subsp. refracta*	Silver-leaved Grevillea			0	Unknown	2	1971	0	Unknown
Flowering Plants	Proteaceae	*Grevillea striata*	Western Beefwood			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Proteaceae	*Hakea arborescens*	Yellow Hakea			0	Unknown	2	1977	0	Unknown
Flowering Plants	Proteaceae	*Hakea chordophylla*	Northern Corkwood			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Proteaceae	*Hakea lorea subsp. borealis*	Northern Long-leaf Corkwood			0	Unknown	2	1947	0	Unknown
Flowering Plants	Proteaceae	*Persoonia falcata*	Milky Plum			0	Unknown	0	Unknown	0	Unknown

Group	Family Name	Scientific Name	Common Name	NT Status	National Status	#Observations	#Latest Observation Date	#Specimens	#Latest Speciman Date	#Surveys	#Latest Survey Record
Flowering Plants	Proteaceae	*Stenocarpus acacioides*	Stenocarpus			0	Unknown	2	1986	0	Unknown
Flowering Plants	Dilleniaceae	*Hibbertia lepidota*	Scaly Guinea Flower			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Droseraceae	*Drosera indica*	Narrow-leaved Sundew			0	Unknown	2	2001	0	Unknown
Flowering Plants	Caryophyllaceae	*Polycarpaea breviflora*	Polycarpaea			0	Unknown	2	1991	0	Unknown
Flowering Plants	Caryophyllaceae	*Polycarpaea corymbosa*	Polycarpaea			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Caryophyllaceae	*Polycarpaea involucrata*	Polycarpaea			0	Unknown	3	1987	0	Unknown
Flowering Plants	Caryophyllaceae	*Polycarpaea spirostylis*	Copper Plant			0	Unknown	2	1971	0	Unknown
Flowering Plants	Amaranthaceae	*Achyranthes aspera*	Prickly Chaff Flower			0	Unknown	5	1986	0	Unknown
Flowering Plants	Amaranthaceae	*Alternanthera denticulata var. denticulata*	Lesser Joyweed			0	Unknown	2	1991	0	Unknown
Flowering Plants	Amaranthaceae	*Alternanthera nana*	Hairy Joyweed			0	Unknown	4	1988	0	Unknown
Flowering Plants	Amaranthaceae	*Alternanthera nodiflora*	Common Joyweed			0	Unknown	2	1986	0	Unknown
Flowering Plants	Amaranthaceae	*Amaranthus interruptus*	Native Amaranth			0	Unknown	2	1977	0	Unknown
Flowering Plants	Amaranthaceae	*Amaranthus pallidiflorus*	Pale-flowered Amaranth			0	Unknown	2	1977	0	Unknown
Flowering Plants	Amaranthaceae	*Gomphrena breviflora*	Gomphrena			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Amaranthaceae	*Gomphrena canescens*	Batchelor`s Buttons			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Amaranthaceae	*Gomphrena canescens subsp. canescens*	Batchelor`s Buttons			0	Unknown	2	1987	0	Unknown
Flowering Plants	Amaranthaceae	*Gomphrena flaccida*	Gomphrena Weed			0	Unknown	6	1995	0	Unknown
Flowering Plants	Amaranthaceae	*Gomphrena lanata*	Gomphrena			0	Unknown	7	1986	0	Unknown
Flowering Plants	Amaranthaceae	*Ptilotus exaltatus*	Pink Mulla Mulla			0	Unknown	6	2008	0	Unknown
Flowering Plants	Amaranthaceae	*Ptilotus fusiformis*	Skeleton plant			0	Unknown	6	1988	0	Unknown
Flowering Plants	Amaranthaceae	*Ptilotus polystachyus*	Long Pussy-tails			0	Unknown	4	2008	0	Unknown
Flowering Plants	Amaranthaceae	*Ptilotus spicatus*	Mulla Mulla			0	Unknown	2	1986	0	Unknown
Flowering Plants	Amaranthaceae	*Salsola australis*	Rolypoly			0	Unknown	2	1979	0	Unknown
Flowering Plants	Molluginaceae	*Glinus lotoides*	Hairy Carpet-weed			0	Unknown	2	1959	0	Unknown
Flowering Plants	Molluginaceae	*Glinus oppositifolius*	Slender Carpet-weed			0	Unknown	2	1977	0	Unknown
Flowering Plants	Portulacaceae	*Calandrinia quadrivalvis*	Parakeelya			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Portulacaceae	*Calandrinia uniflora*	Parakeelya			0	Unknown	2	1988	0	Unknown
Flowering Plants	Portulacaceae	*Portulaca bicolor*	Heart Plant			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Portulacaceae	*Portulaca sp. Elliott*	Pigweed			0	Unknown	2	1986	0	Unknown
Flowering Plants	Nyctaginaceae	*Boerhavia coccinea*	Scarlet Tar Vine			0	Unknown	6	1988	0	Unknown
Flowering Plants	Nyctaginaceae	*Boerhavia dominii*	Tar Vine			0	Unknown	4	1986	0	Unknown
Flowering Plants	Opiliaceae	*Opilia amentacea*	Opilia			0	Unknown	2	1977	0	Unknown
Flowering Plants	Santalaceae	*Santalum lanceolatum*	Plumbush			0	Unknown	8	1988	0	Unknown
Flowering Plants	Loranthaceae	*Amyema bifurcata*	Twin-fork Mistletoe			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Loranthaceae	*Amyema maidenii subsp. maidenii*	Pale-leaf Mistletoe			0	Unknown	2	1979	0	Unknown
Flowering Plants	Loranthaceae	*Amyema miquelii*	Box Mistletoe			0	Unknown	2	1947	0	Unknown
Flowering Plants	Loranthaceae	*Amyema sanguinea*	Blood Mistletoe			0	Unknown	2	1986	0	Unknown
Flowering Plants	Loranthaceae	*Amyema villiflora*	Mistletoe			0	Unknown	2	1987	0	Unknown
Flowering Plants	Loranthaceae	*Dendrophthoe glabrescens*	Orange-Flowered Mistletoe			0	Unknown	4	1979	0	Unknown
Flowering Plants	Loranthaceae	*Diplatia grandibractea*	Royal Mistletoe			0	Unknown	2	1979	0	Unknown
Flowering Plants	Loranthaceae	*Lysiana spathulata subsp. spathulata*	Flat-leaved Mistletoe			0	Unknown	2	1959	0	Unknown
Flowering Plants	Haloragaceae	*Myriophyllum filiforme*	Water Milfoil			0	Unknown	2	1991	0	Unknown
Flowering Plants	Vitaceae	*Cayratia trifolia*	Native Grape			0	Unknown	2	1988	0	Unknown

Group	Family Name	Scientific Name	Common Name	NT Status	National Status	#Observations	#Latest Observation Date	#Specimens	#Latest Speciman Date	#Surveys	#Latest Survey Record
Flowering Plants	Combretaceae	*Macropteranthes kekwickii*	Bullwaddy			0	Unknown	19	2001	0	Unknown
Flowering Plants	Combretaceae	*Terminalia bursarina*	Bendee			0	Unknown	8	1987	0	Unknown
Flowering Plants	Combretaceae	*Terminalia canescens*	Winged Nut Tree			0	Unknown	14	2008	0	Unknown
Flowering Plants	Combretaceae	*Terminalia platyphylla*	Red Plum			0	Unknown	5	1987	0	Unknown
Flowering Plants	Combretaceae	*Terminalia pterocarya*	Wing-fruited Terminalia			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Combretaceae	*Terminalia volucris*	Rosewood			0	Unknown	4	1991	0	Unknown
Flowering Plants	Lythraceae	*Ammannia multiflora*	Jerry-Jerry			0	Unknown	4	1986	0	Unknown
Flowering Plants	Lythraceae	*Nesaea muelleri*	Neasea			0	Unknown	4	1994	0	Unknown
Flowering Plants	Lythraceae	*Rotala diandra*	Rotala			0	Unknown	2	1991	0	Unknown
Flowering Plants	Lythraceae	*Rotala mexicana*	Rotala			0	Unknown	4	1994	0	Unknown
Flowering Plants	Onagraceae	*Ludwigia octovalvis*	Willow Primrose			0	Unknown	2	1988	0	Unknown
Flowering Plants	Onagraceae	*Ludwigia perennis*	Ludwigia			0	Unknown	2	1971	0	Unknown
Flowering Plants	Myrtaceae	*Calytrix exstipulata*	Turkey Bush			0	Unknown	10	1988	0	Unknown
Flowering Plants	Myrtaceae	*Corymbia bella*	Ghost Gum			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Myrtaceae	*Corymbia confertiflora*	Roughleaf Cabbage Gum			0	Unknown	4	1988	0	Unknown
Flowering Plants	Myrtaceae	*Corymbia dichromophloia*	Variable-barked Bloodwood			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Myrtaceae	*Corymbia drysdalensis*	Bloodwood			0	Unknown	5	1993	0	Unknown
Flowering Plants	Myrtaceae	*Corymbia ferruginea*	Rusty Bloodwood			0	Unknown	3	1986	0	Unknown
Flowering Plants	Myrtaceae	*Corymbia ferruginea subsp. ferruginea*	Rusty Bloodwood			0	Unknown	2	1987	0	Unknown
Flowering Plants	Myrtaceae	*Corymbia flavescens*	Cabbage Gum			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Myrtaceae	*Corymbia grandifolia*	Large-leaved Cabbage Gum			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Myrtaceae	*Corymbia grandifolia subsp. grandifolia*	Large-leaved Cabbage Gum			0	Unknown	2	1988	0	Unknown
Flowering Plants	Myrtaceae	*Corymbia polycarpa*	Long-fruited Bloodwood			0	Unknown	5	1988	0	Unknown
Flowering Plants	Myrtaceae	*Corymbia ptychocarpa*	Swamp Bloodwood			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Myrtaceae	*Corymbia ptychocarpa subsp. ptychocarpa*	Swamp Bloodwood			0	Unknown	2	1986	0	Unknown
Flowering Plants	Myrtaceae	*Corymbia terminalis*	Northern Bloodwood			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Myrtaceae	*Eucalyptus brevifolia*	Snappy Gum			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Myrtaceae	*Eucalyptus camaldulensis subsp. obtusa*	Northern River Red Gum			0	Unknown	10	1991	0	Unknown
Flowering Plants	Myrtaceae	*Eucalyptus chlorophylla*	Green-leaf Box			0	Unknown	11	2001	0	Unknown
Flowering Plants	Myrtaceae	*Eucalyptus chlorophylla subsp. chlorophylla*	Greenleaf Box			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Myrtaceae	*Eucalyptus cyanoclada*	Box			0	Unknown	4	2001	0	Unknown
Flowering Plants	Myrtaceae	*Eucalyptus distans*	Katherine Box			0	Unknown	2	1987	0	Unknown
Flowering Plants	Myrtaceae	*Eucalyptus leucophloia*	Snappy Gum			0	Unknown	4	1988	0	Unknown
Flowering Plants	Myrtaceae	*Eucalyptus leucophloia subsp. euroa*	Snappy Gum			0	Unknown	2	1988	0	Unknown
Flowering Plants	Myrtaceae	*Eucalyptus microtheca*	Western Coolibah			0	Unknown	2	1987	0	Unknown
Flowering Plants	Myrtaceae	*Eucalyptus miniata*	Darwin Woollybutt			0	Unknown	2	1971	0	Unknown
Flowering Plants	Myrtaceae	*Eucalyptus patellaris*	Weeping Box			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Myrtaceae	*Eucalyptus pruinosa*	Silver-leaf Box			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Myrtaceae	*Eucalyptus pruinosa subsp. pruinosa*	Silver-leaf Box			0	Unknown	3	1988	0	Unknown

Group	Family Name	Scientific Name	Common Name	NT Status	National Status	#Observations	#Latest Observation Date	#Specimens	#Latest Speciman Date	#Surveys	#Latest Survey Record
Flowering Plants	Myrtaceae	*Eucalyptus pruinosa subsp. tenuata*	Silver-leaf Box			0	Unknown	4	1988	0	Unknown
Flowering Plants	Myrtaceae	*Eucalyptus tectifica*	McArthur River Box			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Myrtaceae	*Eucalyptus tetrodonta*	Darwin Stringybark			0	Unknown	2	1988	0	Unknown
Flowering Plants	Myrtaceae	*Lithomyrtus hypoleuca*	Lithomyrtus			0	Unknown	2	1977	0	Unknown
Flowering Plants	Myrtaceae	*Lophostemon grandiflorus*	Northern Swamp Box			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Myrtaceae	*Melaleuca acacioides*	Coastal Paperbark			0	Unknown	2	1988	0	Unknown
Flowering Plants	Myrtaceae	*Melaleuca argentea*	Silver-leaved Paperbark			0	Unknown	2	1988	0	Unknown
Flowering Plants	Myrtaceae	*Melaleuca citrolens*	Lemon-scented Paperbark			0	Unknown	9	1988	0	Unknown
Flowering Plants	Myrtaceae	*Melaleuca leucadendra*	Weeping Paperbark			0	Unknown	2	1988	0	Unknown
Flowering Plants	Myrtaceae	*Melaleuca nervosa*	Yellow-barked Paperbark			0	Unknown	2	1988	0	Unknown
Flowering Plants	Myrtaceae	*Melaleuca viridiflora*	Broad-leaved Paperbark			0	Unknown	4	1988	0	Unknown
Flowering Plants	Zygophyllaceae	*Tribulopis angustifolia*	Tribulopis			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Celastraceae	*Denhamia cunninghamii*	Yellowberry Bush			0	Unknown	8	1988	0	Unknown
Flowering Plants	Celastraceae	*Denhamia obscura*	Orange Root			0	Unknown	2	1988	0	Unknown
Flowering Plants	Celastraceae	*Stackhousia intermedia*	Wiry Stackhousia			0	Unknown	2	1977	0	Unknown
Flowering Plants	Violaceae	*Hybanthus aurantiacus*	Orange Spade Flower			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Violaceae	*Hybanthus enneaspermus*	Blue Spade Flower			0	Unknown	7	1986	0	Unknown
Flowering Plants	Violaceae	*Hybanthus enneaspermus subsp. enneaspermus*	Blue Spade Flower			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Euphorbiaceae	*Euphorbia biconvexa*	Euphorbia			0	Unknown	10	1988	0	Unknown
Flowering Plants	Euphorbiaceae	*Euphorbia bifida*	Euphorbia			0	Unknown	4	1988	0	Unknown
Flowering Plants	Euphorbiaceae	*Euphorbia mitchelliana*	Native Gypsophila			0	Unknown	4	1986	0	Unknown
Flowering Plants	Euphorbiaceae	*Euphorbia schultzii var. comans*	Euphorbia			0	Unknown	6	1989	0	Unknown
Flowering Plants	Euphorbiaceae	*Euphorbia schultzii var. schultzii*	Euphorbia			0	Unknown	6	1988	0	Unknown
Flowering Plants	Phyllanthaceae	*Antidesma ghesaembilla*	Black Currant Bush			0	Unknown	2	1986	0	Unknown
Flowering Plants	Phyllanthaceae	*Antidesma parvifolium*	Currant Bush			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Phyllanthaceae	*Breynia cernua*	Breynia			0	Unknown	4	1988	0	Unknown
Flowering Plants	Phyllanthaceae	*Flueggea virosa*	White Currant			0	Unknown	8	1988	0	Unknown
Flowering Plants	Phyllanthaceae	*Flueggea virosa subsp. melanthesoides*	White Currant			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Phyllanthaceae	*Margaritaria dubium-traceyi*	Tracey's Puzzle			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Phyllanthaceae	*Phyllanthus carpentariae*	Phyllanthus			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Phyllanthaceae	*Phyllanthus exilis*	Phyllanthus			0	Unknown	15	1995	0	Unknown
Flowering Plants	Phyllanthaceae	*Phyllanthus fuernrohrii*	Sand Spurge			0	Unknown	2	1988	0	Unknown
Flowering Plants	Phyllanthaceae	*Phyllanthus hebecarpus*	Phyllanthus			0	Unknown	3	1987	0	Unknown
Flowering Plants	Phyllanthaceae	*Phyllanthus indigoferoides*	Phyllanthus			0	Unknown	1	1971	0	Unknown
Flowering Plants	Phyllanthaceae	*Phyllanthus maderaspatensis*	Phyllanthus			0	Unknown	2	1988	0	Unknown
Flowering Plants	Phyllanthaceae	*Phyllanthus minutiflorus*	Phyllanthus			0	Unknown	2	1989	0	Unknown
Flowering Plants	Phyllanthaceae	*Phyllanthus virgatus*	Seed-under-leaf			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Phyllanthaceae	*Poranthera microphylla*	Small Poranthera			0	Unknown	4	1977	0	Unknown
Flowering Plants	Phyllanthaceae	*Sauropus rhytidospermus*	Sauropus			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Picrodendraceae	*Petalostigma banksii*	Quinine Bush			0	Unknown	4	1987	0	Unknown
Flowering Plants	Picrodendraceae	*Petalostigma pubescens*	Quinine Tree			0	Unknown	10	1988	0	Unknown

Group	Family Name	Scientific Name	Common Name	NT Status	National Status	#Observations	#Latest Observation Date	#Specimens	#Latest Speciman Date	#Surveys	#Latest Survey Record
Flowering Plants	Erythroxylaceae	*Erythroxylum ellipticum*	Kerosene Wood			0	Unknown	2	1988	0	Unknown
Flowering Plants	Fabaceae	*Abrus precatorius*	Crab`s Eye			0	Unknown	3	1988	0	Unknown
Flowering Plants	Fabaceae	*Abrus precatorius subsp. precatorius*	Crab`s Eye			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Fabaceae	*Acacia alleniana*	Needle-leaved Wattle			0	Unknown	3	1986	0	Unknown
Flowering Plants	Fabaceae	*Acacia ancistrocarpa*	Fitzroy Wattle			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Fabaceae	*Acacia calligera*	Wattle			0	Unknown	39	1993	0	Unknown
Flowering Plants	Fabaceae	*Acacia conspersa*	Wattle			0	Unknown	2	1971	0	Unknown
Flowering Plants	Fabaceae	*Acacia difficilis*	River Wattle			0	Unknown	4	1987	0	Unknown
Flowering Plants	Fabaceae	*Acacia dimidiata*	Swamp Wattle			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Fabaceae	*Acacia drepanocarpa subsp. latifolia*	Wattle			0	Unknown	2	1977	0	Unknown
Flowering Plants	Fabaceae	*Acacia galioides*	Wattle			0	Unknown	28	1986	0	Unknown
Flowering Plants	Fabaceae	*Acacia gonoclada*	Wattle			0	Unknown	8	1992	0	Unknown
Flowering Plants	Fabaceae	*Acacia hammondii*	Wattle			0	Unknown	11	1991	0	Unknown
Flowering Plants	Fabaceae	*Acacia hemignosta*	Club-leaf Wattle			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Fabaceae	*Acacia holosericea*	Candelabra Wattle			0	Unknown	4	1991	0	Unknown
Flowering Plants	Fabaceae	*Acacia humifusa*	Cape York Wattle			0	Unknown	2	1977	0	Unknown
Flowering Plants	Fabaceae	*Acacia latescens*	Ball Wattle			0	Unknown	4	1977	0	Unknown
Flowering Plants	Fabaceae	*Acacia limbata*	Wattle			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Fabaceae	*Acacia lycopodiifolia*	Cypress Wattle			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Fabaceae	*Acacia lysiphloia*	Turpentine Bush			0	Unknown	2	1987	0	Unknown
Flowering Plants	Fabaceae	*Acacia megalantha*	Wattle			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Fabaceae	*Acacia monticola*	Hill Turpentine			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Fabaceae	*Acacia oncinocarpa*	Wattle			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Fabaceae	*Acacia platycarpa*	Ghost Wattle			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Fabaceae	*Acacia plectocarpa*	Wattle			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Fabaceae	*Acacia plectocarpa subsp. tanumbirinensis*	Wattle			0	Unknown	4	1988	0	Unknown
Flowering Plants	Fabaceae	*Acacia shirleyi*	Lancewood			0	Unknown	5	1991	0	Unknown
Flowering Plants	Fabaceae	*Acacia sublanata*	Spiny Wattle			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Fabaceae	*Acacia subternata*	Wattle			0	Unknown	6	1986	0	Unknown
Flowering Plants	Fabaceae	*Acacia umbellata*	Wattle			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Fabaceae	*Acacia wickhamii*	Wickham`s Wattle			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Fabaceae	*Acacia wickhamii subsp. wickhamii*	Wattle			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Fabaceae	*Aeschynomene indica*	Budda Pea			0	Unknown	2	1959	0	Unknown
Flowering Plants	Fabaceae	*Bauhinia cunninghamii*	Butterfly Tree			0	Unknown	4	1987	0	Unknown
Flowering Plants	Fabaceae	*Bossiaea bossiaeoides*	Holly-leaved Pea-flower			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Fabaceae	*Cajanus pubescens*	Pigeon-pea			0	Unknown	8	1986	0	Unknown
Flowering Plants	Fabaceae	*Chamaecrista absus var. absus*	Hairy Cassia			0	Unknown	12	1995	0	Unknown
Flowering Plants	Fabaceae	*Chamaecrista mimosoides*	Five-leafed Cassia			0	Unknown	2	1986	0	Unknown
Flowering Plants	Fabaceae	*Chamaecrista nomame*	Cassia			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Fabaceae	*Chamaecrista nomame var. nomame*	Cassia			0	Unknown	2	1991	0	Unknown
Flowering Plants	Fabaceae	*Chamaecrista symonii*	Dwarf Cassia			0	Unknown	6	1985	0	Unknown

Group	Family Name	Scientific Name	Common Name	NT Status	National Status	#Observations	#Latest Observation Date	#Specimens	#Latest Speciman Date	#Surveys	#Latest Survey Record
Flowering Plants	Fabaceae	*Crotalaria brevis*	Rattlepod			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Fabaceae	*Crotalaria medicaginea*	Trefoil Rattlepod			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Fabaceae	*Crotalaria medicaginea var. neglecta*	Trefoil Rattlepod			0	Unknown	2	1986	0	Unknown
Flowering Plants	Fabaceae	*Crotalaria montana*	Rattlepod			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Fabaceae	*Crotalaria montana var. angustifolia*	Rattlepod			0	Unknown	2	1988	0	Unknown
Flowering Plants	Fabaceae	*Crotalaria novae-hollandiae*	New Holland Rattlepod			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Fabaceae	*Crotalaria ramosissima*	Rattlepod			0	Unknown	1	1988	0	Unknown
Flowering Plants	Fabaceae	*Cullen cinereum*	Annual Verbine			0	Unknown	2	1947	0	Unknown
Flowering Plants	Fabaceae	*Cullen plumosum*	Scurf-pea			0	Unknown	6	1987	0	Unknown
Flowering Plants	Fabaceae	*Desmodium brachypodum*	Large Tick-trefoil			0	Unknown	4	1989	0	Unknown
Flowering Plants	Fabaceae	*Desmodium campylocaulon*	Creeping Tick-trefoil			0	Unknown	4	2001	0	Unknown
Flowering Plants	Fabaceae	*Desmodium muelleri*	Tick-trefoil			0	Unknown	8	1994	0	Unknown
Flowering Plants	Fabaceae	*Dichrostachys spicata*	Single Thorn Prickly Bush			0	Unknown	2	1986	0	Unknown
Flowering Plants	Fabaceae	*Erythrina vespertilio subsp. vespertilio*	Bat Wing Coral Tree			0	Unknown	2	1987	0	Unknown
Flowering Plants	Fabaceae	*Erythrophleum chlorostachys*	Northern Ironwood			0	Unknown	2	1987	0	Unknown
Flowering Plants	Fabaceae	*Flemingia pauciflora*	Flemingia			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Fabaceae	*Galactia muelleri*	Mueller's Pea			0	Unknown	2	1988	0	Unknown
Flowering Plants	Fabaceae	*Galactia tenuiflora*	Poison Pea			0	Unknown	2	1987	0	Unknown
Flowering Plants	Fabaceae	*Glycine tomentella*	Rusty Glycine			0	Unknown	4	2001	0	Unknown
Flowering Plants	Fabaceae	*Indigofera colutea*	Sticky Indigo			0	Unknown	2	1986	0	Unknown
Flowering Plants	Fabaceae	*Indigofera haplophylla*	Indigo			0	Unknown	6	1988	0	Unknown
Flowering Plants	Fabaceae	*Indigofera linifolia*	Native Indigo			0	Unknown	4	1988	0	Unknown
Flowering Plants	Fabaceae	*Indigofera linnaei*	Birdsville Indigo			0	Unknown	6	1988	0	Unknown
Flowering Plants	Fabaceae	*Indigofera trita*	Indigo			0	Unknown	6	1988	0	Unknown
Flowering Plants	Fabaceae	*Jacksonia dilatata*	Cladode Pea			0	Unknown	4	1977	0	Unknown
Flowering Plants	Fabaceae	*Jacksonia odontoclada*	Jacksonia			0	Unknown	2	1971	0	Unknown
Flowering Plants	Fabaceae	*Mirbelia viminalis*	Yellow Broom			0	Unknown	2	1977	0	Unknown
Flowering Plants	Fabaceae	*Neptunia dimorphantha*	Sensitive Plant			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Fabaceae	*Neptunia gracilis*	Native Sensitive Plant			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Fabaceae	*Neptunia monosperma*	One-seeded Sensitive Plant			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Fabaceae	*Rhynchosia minima*	Native Pea			0	Unknown	6	1988	0	Unknown
Flowering Plants	Fabaceae	*Senna costata*	Cassia			0	Unknown	4	1991	0	Unknown
Flowering Plants	Fabaceae	*Senna venusta*	Graceful Cassia			0	Unknown	2	1986	0	Unknown
Flowering Plants	Fabaceae	*Sesbania muelleri*	Peabush			0	Unknown	1	1986	0	Unknown
Flowering Plants	Fabaceae	*Tephrosia brachyodon*	Red Pea-bush			0	Unknown	4	1988	0	Unknown
Flowering Plants	Fabaceae	*Tephrosia brachyodon var. longifolia*	Red Pea-bush			0	Unknown	1	1991	0	Unknown
Flowering Plants	Fabaceae	*Tephrosia conspicua*	Tephrosia			0	Unknown	2	1971	0	Unknown
Flowering Plants	Fabaceae	*Tephrosia delestangii*	Tephrosia			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Fabaceae	*Tephrosia leptoclada*	Tephrosia			0	Unknown	4	1986	0	Unknown
Flowering Plants	Fabaceae	*Tephrosia remotiflora*	Tephrosia			0	Unknown	2	1970	0	Unknown
Flowering Plants	Fabaceae	*Tephrosia rosea*	Flinder`s River Poison			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Fabaceae	*Tephrosia simplicifolia*	Tephrosia			0	Unknown	4	1979	0	Unknown

Group	Family Name	Scientific Name	Common Name	NT Status	National Status	#Observations	#Latest Observation Date	#Specimens	#Latest Speciman Date	#Surveys	#Latest Survey Record
Flowering Plants	Fabaceae	*Tephrosia sp. OT Station*	Tephrosia			0	Unknown	8	1986	0	Unknown
Flowering Plants	Fabaceae	*Uraria lagopodioides*	Purple Clover-weed			0	Unknown	6	1989	0	Unknown
Flowering Plants	Fabaceae	*Vachellia ditricha*	Wattle			0	Unknown	6	1986	0	Unknown
Flowering Plants	Fabaceae	*Vachellia valida*	Wattle			0	Unknown	2	1986	0	Unknown
Flowering Plants	Fabaceae	*Vigna lanceolata*	Maloga Bean			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Fabaceae	*Vigna lanceolata var. filiformis*	Maloga Bean			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Fabaceae	*Vigna lanceolata var. lanceolata*	Maloga Bean			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Fabaceae	*Zornia albiflora*	Zornia			0	Unknown	2	1947	0	Unknown
Flowering Plants	Fabaceae	*Zornia muriculata*	Zornia			0	Unknown	6	1988	0	Unknown
Flowering Plants	Fabaceae	*Zornia muriculata subsp. angustata*	Zornia			0	Unknown	2	1972	0	Unknown
Flowering Plants	Fabaceae	*Zornia prostrata*	Zornia			0	Unknown	2	1986	0	Unknown
Flowering Plants	Polygalaceae	*Polygala barbata*	Milkwort			0	Unknown	4	1991	0	Unknown
Flowering Plants	Polygalaceae	*Polygala longifolia*	Milkwort			0	Unknown	2	1995	0	Unknown
Flowering Plants	Polygalaceae	*Polygala orbicularis*	Milkwort			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Polygalaceae	*Polygala pterocarpa*	Milkwort			0	Unknown	2	2007	0	Unknown
Flowering Plants	Rhamnaceae	*Alphitonia excelsa*	Red Ash			0	Unknown	7	1989	0	Unknown
Flowering Plants	Rhamnaceae	*Ventilago viminalis*	Supplejack			0	Unknown	2	1987	0	Unknown
Flowering Plants	Cannabaceae	*Trema tomentosa*	Peach-leaved Poison-bush			0	Unknown	2	1977	0	Unknown
Flowering Plants	Moraceae	*Ficus cerasicarpa*	Fig			0	Unknown	6	1987	0	Unknown
Flowering Plants	Moraceae	*Ficus subpuberula*	Fig			0	Unknown	4	1977	0	Unknown
Flowering Plants	Moraceae	*Ficus virens var. virens*	Banyan			0	Unknown	2	1977	0	Unknown
Flowering Plants	Cucurbitaceae	*Cucumis argenteus*	Melon			0	Unknown	2	2008	0	Unknown
Flowering Plants	Cucurbitaceae	*Cucumis melo*	Ulcardo Melon			0	Unknown	0	Unknown	5	1991
Flowering Plants	Casuarinaceae	*Casuarina cunninghamiana subsp. miodon*	River Oak			0	Unknown	2	1988	0	Unknown
Flowering Plants	Capparaceae	*Capparis lasiantha*	Split-arse-jack			0	Unknown	2	1987	0	Unknown
Flowering Plants	Capparaceae	*Capparis umbonata*	Northern Wild Orange			0	Unknown	4	1986	0	Unknown
Flowering Plants	Cleomaceae	*Cleome viscosa*	Tickweed			0	Unknown	4	1991	0	Unknown
Flowering Plants	Bixaceae	*Cochlospermum fraseri*	Kapok Bush			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Bixaceae	*Cochlospermum gregorii*	Cotton Tree			0	Unknown	5	1989	0	Unknown
Flowering Plants	Malvaceae	*Abutilon fraseri subsp. fraseri*	Dwarf Lantern-bush			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Malvaceae	*Abutilon hannii*	Mallow			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Malvaceae	*Abutilon hannii subsp. prostrate*	Lantern Bush			0	Unknown	7	1988	0	Unknown
Flowering Plants	Malvaceae	*Abutilon otocarpum*	Desert Chinese Lantern			0	Unknown	6	1991	0	Unknown
Flowering Plants	Malvaceae	*Brachychiton diversifolius subsp. diversifolius*	Northern Kurrajong			0	Unknown	2	1977	0	Unknown
Flowering Plants	Malvaceae	*Brachychiton paradoxus*	Red-flowering Kurrajong			0	Unknown	2	1991	0	Unknown
Flowering Plants	Malvaceae	*Corchorus aestuans*	Grubweed			0	Unknown	2	1988	0	Unknown
Flowering Plants	Malvaceae	*Corchorus sidoides*	Flannel Weed			0	Unknown	2	1991	0	Unknown
Flowering Plants	Malvaceae	*Corchorus sidoides subsp. sidoides*	Flannel Weed			0	Unknown	8	1991	0	Unknown

Group	Family Name	Scientific Name	Common Name	NT Status	National Status	#Observations	#Latest Observation Date	#Specimens	#Latest Speciman Date	#Surveys	#Latest Survey Record
Flowering Plants	Malvaceae	*Corchorus sidoides subsp. vermicularis*	Flannel Weed			0	Unknown	2	1992	0	Unknown
Flowering Plants	Malvaceae	*Corchorus tridens*	Grubweed			0	Unknown	2	2001	0	Unknown
Flowering Plants	Malvaceae	*Gossypium australe*	Native Cotton			0	Unknown	5	1991	0	Unknown
Flowering Plants	Malvaceae	*Grewia breviflora*	Coffee Fruit			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Malvaceae	*Grewia mesomischa*	Grewia			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Malvaceae	*Grewia retusifolia*	Emu Berries			0	Unknown	8	1987	0	Unknown
Flowering Plants	Malvaceae	*Helicteres isora*	Spiral Bush			0	Unknown	2	1972	0	Unknown
Flowering Plants	Malvaceae	*Herissantia crispa*	Indian Mallow			0	Unknown	6	1991	0	Unknown
Flowering Plants	Malvaceae	*Hibiscus leptocladus*	Variable-leaf Hibiscus			0	Unknown	2	1972	0	Unknown
Flowering Plants	Malvaceae	*Hibiscus meraukensis*	Ballerina Hibiscus			0	Unknown	8	1989	0	Unknown
Flowering Plants	Malvaceae	*Hibiscus pentaphyllus*	Native Hibiscus			0	Unknown	11	1991	0	Unknown
Flowering Plants	Malvaceae	*Hibiscus sturtii*	Sturt`s Hibiscus			0	Unknown	4	1989	0	Unknown
Flowering Plants	Malvaceae	*Hibiscus sturtii var. campylochlamys*	Sturt`s Hibiscus			0	Unknown	10	1979	0	Unknown
Flowering Plants	Malvaceae	*Hibiscus sturtii var. grandiflorus*	Sturt`s Hibiscus			0	Unknown	2	1987	0	Unknown
Flowering Plants	Malvaceae	*Hibiscus verdcourtii*	Bladder Ketmia			0	Unknown	4	1979	0	Unknown
Flowering Plants	Malvaceae	*Hibiscus zonatus*	Pink Perennial Hibiscus			0	Unknown	1	1977	0	Unknown
Flowering Plants	Malvaceae	*Melhania oblongifolia*	Velvet Hibiscus			0	Unknown	6	1987	0	Unknown
Flowering Plants	Malvaceae	*Sida brachypoda*	Sida			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Malvaceae	*Sida fibulifera*	Silver Sida			0	Unknown	3	1986	0	Unknown
Flowering Plants	Malvaceae	*Sida filiformis*	Fine Sida			0	Unknown	2	1989	0	Unknown
Flowering Plants	Malvaceae	*Sida hackettiana*	Sida			0	Unknown	10	1987	0	Unknown
Flowering Plants	Malvaceae	*Sida rohlenae*	Shrub Sida			0	Unknown	2	1987	0	Unknown
Flowering Plants	Malvaceae	*Sida rohlenae subsp. rohlenae*	Shrub Sida			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Malvaceae	*Sida sp. Mt Bundey*	Sida			0	Unknown	2	2001	0	Unknown
Flowering Plants	Malvaceae	*Sida spinosa*	Spiny Sida			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Malvaceae	*Sida trichopoda*	High Sida			0	Unknown	2	1986	0	Unknown
Flowering Plants	Malvaceae	*Triumfetta fissurata*	Burbark	DD		0	Unknown	2	1977	0	Unknown
Flowering Plants	Malvaceae	*Triumfetta glaucescens*	Burbark			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Malvaceae	*Triumfetta micracantha*	Burbark			0	Unknown	6	1986	0	Unknown
Flowering Plants	Malvaceae	*Triumfetta plumigera*	Burbark			0	Unknown	6	1986	0	Unknown
Flowering Plants	Malvaceae	*Waltheria indica*	Waltheria			0	Unknown	3	1987	0	Unknown
Flowering Plants	Thymelaeaceae	*Thecanthes punicea*	Red Wax Plant			0	Unknown	6	2001	0	Unknown
Flowering Plants	Thymelaeaceae	*Thecanthes sanguinea*	Thecanthes			0	Unknown	2	1985	0	Unknown
Flowering Plants	Sapindaceae	*Atalaya hemiglauca*	Whitewood			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Sapindaceae	*Dodonaea hispidula*	False Hopbush			0	Unknown	1	1986	0	Unknown
Flowering Plants	Sapindaceae	*Dodonaea lanceolata*	Yellow Hop-bush			0	Unknown	2	1987	0	Unknown
Flowering Plants	Sapindaceae	*Dodonaea lanceolata var. lanceolata*	Yellow Hop-bush			0	Unknown	2	1979	0	Unknown
Flowering Plants	Sapindaceae	*Dodonaea oxyptera*	Hop Bush			0	Unknown	2	1977	0	Unknown
Flowering Plants	Sapindaceae	*Dodonaea physocarpa*	Balloon Hopbush			0	Unknown	17	1989	0	Unknown
Flowering Plants	Sapindaceae	*Dodonaea platyptera*	Hop Bush			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Sapindaceae	*Dodonaea stenophylla*	Netted Hopbush			0	Unknown	15	2001	0	Unknown
Flowering Plants	Meliaceae	*Owenia vernicosa*	Emu Apple			0	Unknown	2	1988	0	Unknown

Group	Family Name	Scientific Name	Common Name	NT Status	National Status	#Observations	#Latest Observation Date	#Specimens	#Latest Speciman Date	#Surveys	#Latest Survey Record
Flowering Plants	Rutaceae	*Boronia lanceolata*	Boronia			0	Unknown	2	1977	0	Unknown
Flowering Plants	Ebenaceae	*Diospyros humilis*	Small-leaved Ebony			0	Unknown	2	1987	0	Unknown
Flowering Plants	Ebenaceae	*Diospyros rugosula*	Iron Tree			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Boraginaceae	*Coldenia procumbens*	Coldenia			0	Unknown	2	1988	0	Unknown
Flowering Plants	Boraginaceae	*Ehretia saligna*	Coonta			0	Unknown	2	1988	0	Unknown
Flowering Plants	Boraginaceae	*Ehretia saligna var. membranifolia*	Coonta			0	Unknown	4	1988	0	Unknown
Flowering Plants	Boraginaceae	*Heliotropium bracteatum*	Heliotrope			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Boraginaceae	*Heliotropium glabellum*	Heliotrope			0	Unknown	4	1986	0	Unknown
Flowering Plants	Boraginaceae	*Heliotropium tenuifolium*	Devil's Son			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Boraginaceae	*Trichodesma zeylanicum*	Cattle Bush			0	Unknown	2	1988	0	Unknown
Flowering Plants	Rubiaceae	*Gardenia ewartii subsp. ewartii*	Native Gardenia			0	Unknown	6	1988	0	Unknown
Flowering Plants	Rubiaceae	*Gardenia megasperma*	Native Gardenia			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Rubiaceae	*Gardenia pyriformis subsp. orientalis*	Native Gardenia			0	Unknown	2	1977	0	Unknown
Flowering Plants	Rubiaceae	*Oldenlandia argillacea*	Oldenlandia			0	Unknown	2	1986	0	Unknown
Flowering Plants	Rubiaceae	*Oldenlandia galioides*	Oldenlandia			0	Unknown	4	1995	0	Unknown
Flowering Plants	Rubiaceae	*Oldenlandia mitrasacmoides*	Oldenlandia			0	Unknown	4	1991	0	Unknown
Flowering Plants	Rubiaceae	*Psydrax attenuata var. myrmecophila*	Canthium			0	Unknown	2	1977	0	Unknown
Flowering Plants	Rubiaceae	*Spermacoce auriculata*	Buttonweed			0	Unknown	2	1988	0	Unknown
Flowering Plants	Rubiaceae	*Spermacoce brachystema*	Buttonweed	DD		0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Rubiaceae	*Spermacoce dolichosperma*	Buttonweed			0	Unknown	10	2001	0	Unknown
Flowering Plants	Rubiaceae	*Spermacoce platyloba*	Buttonweed			0	Unknown	2	1977	0	Unknown
Flowering Plants	Rubiaceae	*Spermacoce stenophylla*	Blue Buttonweed			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Rubiaceae	*Tarenna dallachiana subsp. expandens*	Tree Ixora			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Loganiaceae	*Mitrasacme micrantha*	Mitre Plant			0	Unknown	2	2001	0	Unknown
Flowering Plants	Apocynaceae	*Carissa lanceolata*	Conkerberry			0	Unknown	4	1987	0	Unknown
Flowering Plants	Apocynaceae	*Marsdenia australis*	Bush Banana			0	Unknown	4	1987	0	Unknown
Flowering Plants	Apocynaceae	*Marsdenia geminata*	Milkvine			0	Unknown	6	2001	0	Unknown
Flowering Plants	Apocynaceae	*Marsdenia trinervis*	Milkvine			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Apocynaceae	*Marsdenia viridiflora subsp. tropica*	Bush Banana			0	Unknown	4	1988	0	Unknown
Flowering Plants	Apocynaceae	*Sarcostemma viminale*	Caustic Vine			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Apocynaceae	*Sarcostemma viminale subsp. brunonianum*	Caustic Vine			0	Unknown	2	1979	0	Unknown
Flowering Plants	Apocynaceae	*Secamone elliptica*	Corky Milk Vine			0	Unknown	7	1991	0	Unknown
Flowering Plants	Apocynaceae	*Tylophora cinerascens*	Tylophora			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Apocynaceae	*Tylophora flexuosa*	Tylophora			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Apocynaceae	*Wrightia saligna*	Milk Bush			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Hydroleaceae	*Hydrolea zeylanica*	False Fiddle-leaf			0	Unknown	3	1991	0	Unknown
Flowering Plants	Solanaceae	*Physalis angulata*	Wild Gooseberry			0	Unknown	2	1988	0	Unknown
Flowering Plants	Solanaceae	*Solanum dioicum*	Wild Tomato			0	Unknown	2	1977	0	Unknown
Flowering Plants	Solanaceae	*Solanum echinatum*	Wild Tomato			0	Unknown	4	1989	0	Unknown
Flowering Plants	Solanaceae	*Solanum ferocissimum*	Spiny Potato-bush			0	Unknown	0	Unknown	0	Unknown

Group	Family Name	Scientific Name	Common Name	NT Status	National Status	#Observations	#Latest Observation Date	#Specimens	#Latest Speciman Date	#Surveys	#Latest Survey Record
Flowering Plants	Solanaceae	*Solanum lucani*	Thorny Nightshade			0	Unknown	4	1972	0	Unknown
Flowering Plants	Convolvulaceae	*Bonamia brevifolia*	Bonamia			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Convolvulaceae	*Bonamia media*	Grey-vine			0	Unknown	3	1991	0	Unknown
Flowering Plants	Convolvulaceae	*Bonamia pannosa*	Bonamia			0	Unknown	4	1986	0	Unknown
Flowering Plants	Convolvulaceae	*Evolvulus alsinoides*	Blue Periwinkle			0	Unknown	8	1987	0	Unknown
Flowering Plants	Convolvulaceae	*Evolvulus alsinoides var. decumbens*	Blue Periwinkle			0	Unknown	2	1979	0	Unknown
Flowering Plants	Convolvulaceae	*Ipomoea argillicola*	Cow-vine			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Convolvulaceae	*Ipomoea eriocarpa*	Small Pink Convolvulus			0	Unknown	2	1986	0	Unknown
Flowering Plants	Convolvulaceae	*Ipomoea gracilis*	Slender Bindweed			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Convolvulaceae	*Ipomoea nil*	Morning Glory			0	Unknown	1	2001	0	Unknown
Flowering Plants	Convolvulaceae	*Ipomoea plebeia*	Bell Vine			0	Unknown	4	2001	0	Unknown
Flowering Plants	Convolvulaceae	*Ipomoea polymorpha*	Silky Cow-vine			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Convolvulaceae	*Jacquemontia paniculata*	Purple-flowered Jungle Creeper			0	Unknown	4	1991	0	Unknown
Flowering Plants	Convolvulaceae	*Merremia gemella*	Merremia			0	Unknown	2	1988	0	Unknown
Flowering Plants	Convolvulaceae	*Merremia incisa*	Merremia	DD		0	Unknown	2	1986	0	Unknown
Flowering Plants	Convolvulaceae	*Operculina aequisepala*	Potato Vine			0	Unknown	2	1979	0	Unknown
Flowering Plants	Convolvulaceae	*Polymeria ambigua*	Creeping Polymeria			0	Unknown	5	1991	0	Unknown
Flowering Plants	Convolvulaceae	*Xenostegia tridentata*	Morning Vine			0	Unknown	2	1987	0	Unknown
Flowering Plants	Oleaceae	*Jasminum molle*	Stiff Jasmine			0	Unknown	8	1989	0	Unknown
Flowering Plants	Acanthaceae	*Brunoniella australis*	Blue Trumpet			0	Unknown	5	1991	0	Unknown
Flowering Plants	Acanthaceae	*Hygrophila angustifolia*	Hygrophila			0	Unknown	4	1983	0	Unknown
Flowering Plants	Acanthaceae	*Hypoestes floribunda*	Rosy Hypoestes			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Acanthaceae	*Hypoestes floribunda var. cinerea*	Rosy Hypoestes			0	Unknown	4	1991	0	Unknown
Flowering Plants	Acanthaceae	*Rostellularia adscendens*	Pink Tongues			0	Unknown	2	1989	0	Unknown
Flowering Plants	Acanthaceae	*Rostellularia adscendens var. clementii*	Pink Tongues			0	Unknown	2	1989	0	Unknown
Flowering Plants	Acanthaceae	*Rostellularia adscendens var. latifolia*	Pink Tongues			0	Unknown	2	1988	0	Unknown
Flowering Plants	Bignoniaceae	*Dolichandrone filiformis*	Whistling Tree			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Bignoniaceae	*Dolichandrone heterophylla*	Lemon Wood			0	Unknown	4	1989	0	Unknown
Flowering Plants	Lamiaceae	*Clerodendrum floribundum*	Smooth Spiderbush			0	Unknown	4	1988	0	Unknown
Flowering Plants	Lamiaceae	*Premna acuminata*	Premna			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Phrymaceae	*Glossostigma diandrum*	Two-Anther Mud-Mat			0	Unknown	2	1991	0	Unknown
Flowering Plants	Phrymaceae	*Peplidium muelleri*	Pepilidium			0	Unknown	4	1995	0	Unknown
Flowering Plants	Orobanchaceae	*Buchnera linearis*	Dainty Bush Flower			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Plantaginaceae	*Bacopa floribunda*	Bacopa			0	Unknown	2	1971	0	Unknown
Flowering Plants	Plantaginaceae	*Stemodia glabella*	Smooth Bluerod			0	Unknown	4	1988	0	Unknown
Flowering Plants	Plantaginaceae	*Stemodia lathraia*	Bluerod			0	Unknown	2	1991	0	Unknown
Flowering Plants	Plantaginaceae	*Stemodia lythrifolia*	Bluerod			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Plantaginaceae	*Stemodia viscosa*	Sticky Bluerod			0	Unknown	2	1978	0	Unknown
Flowering Plants	Plantaginaceae	*Striga curviflora*	Witchweed			0	Unknown	2	1991	0	Unknown
Flowering Plants	Lentibulariaceae	*Utricularia stellaris*	Bladderwort	DD		0	Unknown	4	1987	0	Unknown
Flowering Plants	Araliaceae	*Trachymene didiscoides*	Wild Parsnip			0	Unknown	2	1977	0	Unknown
Flowering Plants	Campanulaceae	*Isotoma sp. Tanumbirini*	Isotome	DD		0	Unknown	4	2001	0	Unknown

Group	Family Name	Scientific Name	Common Name	NT Status	National Status	#Observations	#Latest Observation Date	#Specimens	#Latest Speciman Date	#Surveys	#Latest Survey Record
Flowering Plants	Campanulaceae	*Lobelia dioica*	Lobelia			0	Unknown	4	1991	0	Unknown
Flowering Plants	Campanulaceae	*Lobelia douglasiana*	Slender Lobelia			0	Unknown	2	1991	0	Unknown
Flowering Plants	Campanulaceae	*Wahlenbergia caryophylloides*	Northern Bluebell			0	Unknown	2	1977	0	Unknown
Flowering Plants	Stylidiaceae	*Stylidium adenophorum*	Trigger Plant			0	Unknown	2	1977	0	Unknown
Flowering Plants	Stylidiaceae	*Stylidium floodii*	Trigger Plant			0	Unknown	2	1991	0	Unknown
Flowering Plants	Menyanthaceae	*Nymphoides crenata*	Wavy Marshwort			0	Unknown	7	1994	0	Unknown
Flowering Plants	Goodeniaceae	*Brunonia australis*	Blue Pincushion			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Goodeniaceae	*Goodenia armitiana*	Narrow-leaved Goodenia			0	Unknown	2	1947	0	Unknown
Flowering Plants	Goodeniaceae	*Goodenia byrnesii*	Split-end Goodenia			0	Unknown	2	1991	0	Unknown
Flowering Plants	Goodeniaceae	*Goodenia gracilis*	Slender Goodenia			0	Unknown	7	2001	0	Unknown
Flowering Plants	Goodeniaceae	*Goodenia hispida*	Goodenia			0	Unknown	6	2001	0	Unknown
Flowering Plants	Goodeniaceae	*Goodenia janamba*	Goodenia			0	Unknown	2	1947	0	Unknown
Flowering Plants	Goodeniaceae	*Goodenia lamprosperma*	Goodenia			0	Unknown	6	2001	0	Unknown
Flowering Plants	Goodeniaceae	*Goodenia leiosperma*	Goodenia			0	Unknown	2	1989	0	Unknown
Flowering Plants	Goodeniaceae	*Goodenia odonnellii*	Goodenia			0	Unknown	2	1977	0	Unknown
Flowering Plants	Goodeniaceae	*Goodenia pilosa*	Hairy Goodenia			0	Unknown	4	1991	0	Unknown
Flowering Plants	Goodeniaceae	*Goodenia viscidula*	Goodenia			0	Unknown	4	1991	0	Unknown
Flowering Plants	Goodeniaceae	*Scaevola revoluta*	Fanflower			0	Unknown	4	1983	0	Unknown
Flowering Plants	Asteraceae	*Bidens bipinnata*	Cobbler's Pegs			0	Unknown	4	1989	0	Unknown
Flowering Plants	Asteraceae	*Blumea diffusa*	Daisy			0	Unknown	2	1977	0	Unknown
Flowering Plants	Asteraceae	*Blumea integrifolia*	Daisy			0	Unknown	2	1978	0	Unknown
Flowering Plants	Asteraceae	*Blumea saxatilis*	Daisy			0	Unknown	2	1989	0	Unknown
Flowering Plants	Asteraceae	*Blumea tenella*	Daisy			0	Unknown	8	2001	0	Unknown
Flowering Plants	Asteraceae	*Centipeda minima subsp. macrocephala*	Spreading Sneezeweed			0	Unknown	4	1991	0	Unknown
Flowering Plants	Asteraceae	*Centipeda nidiformis*	Sneezeweed			0	Unknown	2	1987	0	Unknown
Flowering Plants	Asteraceae	*Eclipta sp. Humpty Doo*	Twin-heads			0	Unknown	2	1978	0	Unknown
Flowering Plants	Asteraceae	*Flaveria australasica*	Yellow Twin Stem			0	Unknown	2	1979	0	Unknown
Flowering Plants	Asteraceae	*Pterocaulon serrulatum*	Fruit Salad Bush			0	Unknown	0	Unknown	0	Unknown
Flowering Plants	Asteraceae	*Pterocaulon serrulatum var. velutinum*	Fruit Salad Bush			0	Unknown	2	1987	0	Unknown
Flowering Plants	Asteraceae	*Pterocaulon sphacelatum*	Apple Bush			0	Unknown	4	1988	0	Unknown
Flowering Plants	Asteraceae	*Wedelia verbesinoides*	Daisy			0	Unknown	1	1977	0	Unknown
Frogs	Myobatrachidae	*Crinia bilingua*	Bilingual Froglet			0	Unknown	2	1987	0	Unknown
Frogs	Myobatrachidae	*Crinia deserticola*	Desert Froglet			0	Unknown	12	1977	0	Unknown
Frogs	Myobatrachidae	*Uperoleia lithomoda*	Stonemason Toadlet			0	Unknown	3	2010	0	Unknown
Frogs	Hylidae	*Litoria australis*	Giant Frog			1	1988	2	2006	0	Unknown
Frogs	Hylidae	*Litoria caerulea*	Green Tree-frog			12	2001	0	Unknown	1	1991
Frogs	Hylidae	*Litoria cultripes*	Knife-footed Frog			0	Unknown	1	2001	0	Unknown
Frogs	Hylidae	*Litoria pallida*	Pale Frog			1	1987	14	1987	0	Unknown
Frogs	Hylidae	*Litoria rothii*	Roth`s Tree-Frog			0	Unknown	2	1977	0	Unknown
Frogs	Hylidae	*Litoria rubella*	Red Tree-frog			2	2001	5	1987	0	Unknown
Reptiles	Crocodylidae	*Crocodylus johnstoni*	Freshwater Crocodile			1	1987	0	Unknown	0	Unknown
Reptiles	Gekkonidae	*Diplodactylus conspicillatus*	Fat-tailed Gecko			11	1994	3	1994	2	1991
Reptiles	Gekkonidae	*Gehyra australis*	Northern Dtella			2	1988	6	2001	2	1991

Group	Family Name	Scientific Name	Common Name	NT Status	National Status	#Observations	#Latest Observation Date	#Specimens	#Latest Speciman Date	#Surveys	#Latest Survey Record
Reptiles	Gekkonidae	*Gehyra nana*	Northern Spotted Rock Dtella			0	Unknown	1	1977	0	Unknown
Reptiles	Gekkonidae	*Heteronotia binoei*	Bynoe`s Gecko			2	1988	11	1989	3	1999
Reptiles	Gekkonidae	*Lucasium immaculatum*	Pale-striped Ground Gecko			0	Unknown	1	1994	0	Unknown
Reptiles	Gekkonidae	*Lucasium stenodactylum*	Crowned Gecko			4	1999	3	1988	0	Unknown
Reptiles	Gekkonidae	*Oedura rhombifer*	Zig-zag Gecko			0	Unknown	0	Unknown	2	1999
Reptiles	Gekkonidae	*Rhynchoedura ornata*	Beaked Gecko			3	1994	5	1994	4	1999
Reptiles	Gekkonidae	*Strophurus ciliaris*	Spiny-tailed Gecko			14	1994	0	Unknown	1	1991
Reptiles	Pygopodidae	*Delma borea*	Rusty-topped Delma			2	1994	0	Unknown	0	Unknown
Reptiles	Pygopodidae	*Lialis burtonis*	Burton`s Legless Lizard			17	1994	0	Unknown	0	Unknown
Reptiles	Pygopodidae	*Pygopus steelescotti*	Northern Hooded Scaly-foot			15	1994	0	Unknown	0	Unknown
Reptiles	Scincidae	*Carlia amax*	Two-Spined Rainbow Skink			4	2001	8	1989	1	1993
Reptiles	Scincidae	*Carlia triacantha*	Three-Spined Rainbow Skink			1	1987	2	1987	0	Unknown
Reptiles	Scincidae	*Cryptoblepharus metallicus*	Metallic Snake-eyed Skink			0	Unknown	1	1959	0	Unknown
Reptiles	Scincidae	*Cryptoblepharus plagiocephalus*	Arboreal Snake-eyed Skink			0	Unknown	0	Unknown	4	1991
Reptiles	Scincidae	*Ctenotus borealis*	Northern Ctenotus			0	Unknown	3	1989	0	Unknown
Reptiles	Scincidae	*Ctenotus helenae*	Helen`s Ctenotus			0	Unknown	1	1977	0	Unknown
Reptiles	Scincidae	*Ctenotus inornatus*	Plain Ctenotus			6	1995	5	1994	6	1993
Reptiles	Scincidae	*Ctenotus leonhardii*	Leonhardi`s Ctenotus			1	1995	0	Unknown	0	Unknown
Reptiles	Scincidae	*Ctenotus pantherinus*	Leopard Ctenotus			4	1994	1	1977	2	1991
Reptiles	Scincidae	*Ctenotus pulchellus*	Pretty Ctenotus			1	1994	4	2001	2	1991
Reptiles	Scincidae	*Ctenotus robustus*	Robust Ctenotus			6	1994	3	1988	0	Unknown
Reptiles	Scincidae	*Ctenotus schomburgkii*	Schomburk`s Ctenotus			2	1994	5	1994	2	1991
Reptiles	Scincidae	*Ctenotus spaldingi*	Spalding`s Ctenotus			2	1988	6	2001	1	1999
Reptiles	Scincidae	*Liopholis striata*	Striated Egernia			0	Unknown	1	2001	0	Unknown
Reptiles	Scincidae	*Eremiascincus isolepis*	Smooth-Tailed Skink			2	1994	3	1994	0	Unknown
Reptiles	Scincidae	*Glaphyromorphus darwiniensis*	Darwin Skink			0	Unknown	0	Unknown	2	1991
Reptiles	Scincidae	*Lerista bipes*	Two-Toed Lerista			0	Unknown	1	2001	0	Unknown
Reptiles	Scincidae	*Lerista griffini*	Griffin`s Lerista			0	Unknown	1	1991	2	1991
Reptiles	Scincidae	*Lerista orientalis*	Eastern Lerista			3	1991	4	1991	3	1991
Reptiles	Scincidae	*Menetia greyii*	Grey`s Menetia			2	1988	4	2001	0	Unknown
Reptiles	Scincidae	*Menetia maini*	Main`s Menetia			0	Unknown	0	Unknown	2	1991
Reptiles	Scincidae	*Morethia storri*	Storr`s Snake-Eyed Skink			0	Unknown	2	1988	0	Unknown
Reptiles	Scincidae	*Tiliqua multifasciata*	Centralian Blue-Tongued Lizard			7	1994	0	Unknown	0	Unknown
Reptiles	Scincidae	*Tiliqua scincoides*	Common Blue-Tongued Lizard	DD		3	1994	1	1988	0	Unknown
Reptiles	Agamidae	*Chlamydosaurus kingii*	Frilled Lizard			0	Unknown	0	Unknown	1	1991
Reptiles	Agamidae	*Ctenophorus nuchalis*	Central Netted Dragon			0	Unknown	0	Unknown	1	1993
Reptiles	Agamidae	*Diporiphora bilineata*	Two-Lined Dragon			0	Unknown	1	1971	0	Unknown
Reptiles	Agamidae	*Diporiphora magna*	Yellow-sided Two-line Dragon			0	Unknown	4	2005	0	Unknown
Reptiles	Agamidae	*Lophognathus gilberti*	Gilbert`s Dragon			4	2001	6	2005	7	1993
Reptiles	Varanidae	*Varanus acanthurus*	Ridge-tailed Monitor			5	1995	0	Unknown	0	Unknown

Group	Family Name	Scientific Name	Common Name	NT Status	National Status	#Observations	#Latest Observation Date	#Specimens	#Latest Speciman Date	#Surveys	#Latest Survey Record
Reptiles	Varanidae	*Varanus gouldii*	Sand Goanna			3	2001	1	1999	3	1991
Reptiles	Varanidae	*Varanus mertensi*	Mertens` Water Monitor	VU		3	1993	0	Unknown	1	1993
Reptiles	Varanidae	*Varanus scalaris*	Spotted Tree Monitor	DD		2	1988	0	Unknown	0	Unknown
Reptiles	Varanidae	*Varanus tristis*	Black-tailed Monitor			1	2001	1	1977	0	Unknown
Reptiles	Typhlopidae	*Ramphotyphlops diversus*	Northern Blind Snake			0	Unknown	1	2001	0	Unknown
Reptiles	Typhlopidae	*Ramphotyphlops unguirostris*	Claw-snouted Blind Snake			1	1988	1	1988	0	Unknown
Reptiles	Pythonidae	*Antaresia childreni*	Children`s Python			4	1994	1	1988	1	1991
Reptiles	Elapidae	*Brachyurophis incinctus*	Unbanded Shovel-nosed Snake			1	1994	0	Unknown	0	Unknown
Reptiles	Elapidae	*Brachyurophis roperi*	Northern Shovel-nosed Snake			2	1994	0	Unknown	0	Unknown
Reptiles	Elapidae	*Demansia olivacea*	Olive Whip Snake	DD		2	1994	0	Unknown	0	Unknown
Reptiles	Elapidae	*Demansia papuensis*	Papaun Whip Snake			0	Unknown	1	1978	0	Unknown
Reptiles	Elapidae	*Furina ornata*	Orange-naped Snake			1	1994	1	1994	0	Unknown
Reptiles	Elapidae	*Pseudechis australis*	King Brown Snake			1	1988	0	Unknown	0	Unknown
Reptiles	Elapidae	*Pseudonaja nuchalis*	Western Brown Snake			2	1994	0	Unknown	0	Unknown
Reptiles	Elapidae	*Suta punctata*	Little Spotted Snake			4	1994	0	Unknown	0	Unknown
Birds	Phasianidae	*Coturnix ypsilophora*	Brown Quail			4	2001	0	Unknown	3	1999
Birds	Anatidae	*Chenonetta jubata*	Australian Wood Duck			1	1987	0	Unknown	0	Unknown
Birds	Anatidae	*Anas superciliosa*	Pacific Black Duck			2	1987	0	Unknown	0	Unknown
Birds	Podicipedidae	*Tachybaptus novaehollandiae*	Australasian Grebe			1	1978	0	Unknown	0	Unknown
Birds	Podicipedidae	*Poliocephalus poliocephalus*	Hoary-headed Grebe			1	1988	0	Unknown	0	Unknown
Birds	Columbidae	*Phaps chalcoptera*	Common Bronzewing			3	1999	0	Unknown	1	1993
Birds	Columbidae	*Ocyphaps lophotes*	Crested Pigeon			11	2000	0	Unknown	2	1993
Birds	Columbidae	*Geophaps plumifera*	Spinifex Pigeon			0	Unknown	0	Unknown	1	1993
Birds	Columbidae	*Geopelia cuneata*	Diamond Dove			15	2000	0	Unknown	15	1993
Birds	Columbidae	*Geopelia striata*	Peaceful Dove			23	2000	1	1987	5	1993
Birds	Columbidae	*Geopelia humeralis*	Bar-shouldered Dove			7	2000	0	Unknown	4	1993
Birds	Podargidae	*Podargus strigoides*	Tawny Frogmouth			2	1991	0	Unknown	2	1993
Birds	Eurostopodidae	*Eurostopodus argus*	Spotted Nightjar			3	2000	0	Unknown	0	Unknown
Birds	Aegothelidae	*Aegotheles cristatus*	Australian Owlet-nightjar			4	2001	0	Unknown	4	1993
Birds	Anhingidae	*Anhinga novaehollandiae*	Australasian Darter			1	1987	0	Unknown	0	Unknown
Birds	Phalacrocoracidae	*Microcarbo melanoleucos*	Little Pied Cormorant			1	1987	0	Unknown	0	Unknown
Birds	Pelecanidae	*Pelecanus conspicillatus*	Australian Pelican			1	1987	0	Unknown	0	Unknown
Birds	Ciconiidae	*Ephippiorhynchus asiaticus*	Black-necked Stork			1	2000	0	Unknown	0	Unknown
Birds	Ardeidae	*Ardea pacifica*	White-necked Heron			3	1987	0	Unknown	0	Unknown
Birds	Ardeidae	*Ardea modesta*	Eastern Great Egret			1	1978	0	Unknown	0	Unknown
Birds	Ardeidae	*Egretta novaehollandiae*	White-faced Heron			2	1987	0	Unknown	1	1993
Birds	Ardeidae	*Nycticorax caledonicus*	Nankeen Night Heron			2	1987	0	Unknown	0	Unknown
Birds	Threskiornithidae	*Threskiornis spinicollis*	Straw-necked Ibis			1	1978	0	Unknown	0	Unknown
Birds	Threskiornithidae	*Platalea regia*	Royal Spoonbill			2	1987	0	Unknown	0	Unknown
Birds	Threskiornithidae	*Platalea flavipes*	Yellow-billed Spoonbill			2	1987	0	Unknown	0	Unknown
Birds	Accipitridae	*Elanus axillaris*	Black-shouldered Kite			1	2001	0	Unknown	0	Unknown
Birds	Accipitridae	*Haliastur sphenurus*	Whistling Kite			4	2000	0	Unknown	1	1993
Birds	Accipitridae	*Milvus migrans*	Black Kite			4	2001	0	Unknown	1	1993

Group	Family Name	Scientific Name	Common Name	NT Status	National Status	#Observations	#Latest Observation Date	#Specimens	#Latest Speciman Date	#Surveys	#Latest Survey Record
Birds	Accipitridae	*Accipiter fasciatus*	Brown Goshawk			4	1993	0	Unknown	3	1993
Birds	Accipitridae	*Accipiter cirrocephalus*	Collared Sparrowhawk			1	1998	0	Unknown	1	1993
Birds	Accipitridae	*Circus assimilis*	Spotted Harrier			3	1999	0	Unknown	0	Unknown
Birds	Accipitridae	*Aquila audax*	Wedge-tailed Eagle			3	2000	0	Unknown	2	1993
Birds	Accipitridae	*Hieraaetus morphnoides*	Little Eagle			1	1999	0	Unknown	0	Unknown
Birds	Falconidae	*Falco cenchroides*	Nankeen Kestrel			2	1999	0	Unknown	0	Unknown
Birds	Falconidae	*Falco berigora*	Brown Falcon			16	2001	0	Unknown	3	1993
Birds	Falconidae	*Falco longipennis*	Australian Hobby			1	1979	0	Unknown	1	1993
Birds	Gruidae	*Grus rubicunda*	Brolga			3	1989	0	Unknown	0	Unknown
Birds	Otididae	*Ardeotis australis*	Australian Bustard			7	2000	0	Unknown	0	Unknown
Birds	Burhinidae	*Burhinus grallarius*	Bush Stone-curlew			8	2001	0	Unknown	2	1993
Birds	Charadriidae	*Elseyornis melanops*	Black-fronted Dotterel			2	1987	0	Unknown	0	Unknown
Birds	Charadriidae	*Vanellus miles*	Masked Lapwing			1	1987	0	Unknown	0	Unknown
Birds	Turnicidae	*Turnix maculosus*	Red-backed Button-quail			3	2001	0	Unknown	2	1991
Birds	Turnicidae	*Turnix pyrrhothorax*	Red-chested Button-quail			0	Unknown	0	Unknown	1	1993
Birds	Turnicidae	*Turnix velox*	Little Button-quail			2	1991	0	Unknown	2	1991
Birds	Cacatuidae	*Calyptorhynchus banksii macrorhynchus*	Red-tailed Black-cockatoo	N		14	2001	0	Unknown	0	Unknown
Birds	Cacatuidae	*Eulophus roseicapilla*	Galah			19	2002	0	Unknown	7	1999
Birds	Cacatuidae	*Nymphicus hollandicus*	Cockatiel			6	1999	0	Unknown	1	1993
Birds	Psittacidae	*Trichoglossus haematodus*	Rainbow Lorikeet			0	Unknown	0	Unknown	1	1993
Birds	Psittacidae	*Psitteuteles versicolor*	Varied Lorikeet			3	2001	0	Unknown	1	1993
Birds	Psittacidae	*Aprosmictus erythropterus*	Red-winged Parrot			14	2001	0	Unknown	2	1993
Birds	Psittacidae	*Psephotus dissimilis*	Hooded Parrot			0	Unknown	0	Unknown	1	1993
Birds	Psittacidae	*Melopsittacus undulatus*	Budgerigar			3	1991	0	Unknown	3	1993
Birds	Cuculidae	*Centropus phasianinus*	Pheasant Coucal			3	2001	0	Unknown	1	1993
Birds	Cuculidae	*Eudynamys orientalis*	Eastern Koel			3	1999	0	Unknown	0	Unknown
Birds	Cuculidae	*Scythrops novaehollandiae*	Channel-billed Cuckoo			1	1988	0	Unknown	0	Unknown
Birds	Cuculidae	*Chalcites basalis*	Horsfield`s Bronze-Cuckoo			4	2001	0	Unknown	1	1991
Birds	Cuculidae	*Cacomantis pallidus*	Pallid Cuckoo			2	1998	0	Unknown	0	Unknown
Birds	Cuculidae	*Cacomantis variolosus*	Brush Cuckoo			2	1999	0	Unknown	0	Unknown
Birds	Strigidae	*Ninox novaeseelandiae*	Southern Boobook			6	2001	0	Unknown	3	1991
Birds	Alcedinidae	*Ceyx azureus*	Azure Kingfisher			1	1987	0	Unknown	0	Unknown
Birds	Halcyonidae	*Dacelo leachii*	Blue-winged Kookaburra			4	2001	0	Unknown	0	Unknown
Birds	Halcyonidae	*Todiramphus pyrrhopygius*	Red-backed Kingfisher			2	1991	0	Unknown	2	1991
Birds	Halcyonidae	*Todiramphus sanctus*	Sacred Kingfisher			3	1999	0	Unknown	1	1991
Birds	Meropidae	*Merops ornatus*	Rainbow Bee-eater			12	2001	0	Unknown	2	1993
Birds	Climacteridae	*Climacteris melanura*	Black-tailed Treecreeper			6	2001	0	Unknown	3	1999
Birds	Ptilonorhynchidae	*Ptilonorhynchus nuchalis*	Great Bowerbird			15	2002	0	Unknown	2	1993
Birds	Maluridae	*Malurus melanocephalus*	Red-backed Fairy-wren			9	2001	0	Unknown	1	1993
Birds	Maluridae	*Malurus lamberti*	Variegated Fairy-wren			11	1999	0	Unknown	6	1991
Birds	Acanthizidae	*Smicrornis brevirostris*	Weebill			15	2001	0	Unknown	8	1999
Birds	Acanthizidae	*Gerygone albogularis*	White-throated Gerygone			6	1999	0	Unknown	0	Unknown
Birds	Pardalotidae	*Pardalotus rubricatus*	Red-browed Pardalote			2	2000	0	Unknown	0	Unknown
Birds	Pardalotidae	*Pardalotus striatus*	Striated Pardalote			12	2001	2	1977	5	1999
Birds	Meliphagidae	*Lichenostomus virescens*	Singing Honeyeater			16	2001	0	Unknown	8	1993
Birds	Meliphagidae	*Lichenostomus plumulus*	Grey-fronted Honeyeater			7	2000	0	Unknown	4	1999

Group	Family Name	Scientific Name	Common Name	NT Status	National Status	#Observations	#Latest Observation Date	#Specimens	#Latest Speciman Date	#Surveys	#Latest Survey Record
Birds	Meliphagidae	*Lichenostomus flavescens*	Yellow-tinted Honeyeater			5	2001	0	Unknown	1	1993
Birds	Meliphagidae	*Acanthagenys rufogularis*	Spiny-cheeked Honeyeater			1	1987	0	Unknown	0	Unknown
Birds	Meliphagidae	*Ramsayornis fasciatus*	Bar-breasted Honeyeater			1	1978	0	Unknown	0	Unknown
Birds	Meliphagidae	*Conopophila rufogularis*	Rufous-throated Honeyeater			15	2000	0	Unknown	8	1993
Birds	Meliphagidae	*Cissomela pectoralis*	Banded Honeyeater			3	2001	0	Unknown	0	Unknown
Birds	Meliphagidae	*Lichmera indistincta*	Brown Honeyeater			7	2001	0	Unknown	6	1993
Birds	Meliphagidae	*Melithreptus gularis*	Black-chinned Honeyeater			1	1993	0	Unknown	0	Unknown
Birds	Meliphagidae	*Melithreptus albogularis*	White-throated Honeyeater			2	1999	0	Unknown	0	Unknown
Birds	Meliphagidae	*Entomyzon cyanotis*	Blue-faced Honeyeater			0	Unknown	0	Unknown	1	1993
Birds	Meliphagidae	*Philemon argenticeps*	Silver-crowned Friarbird			1	1999	0	Unknown	2	1993
Birds	Meliphagidae	*Philemon citreogularis*	Little Friarbird			4	2000	0	Unknown	3	1993
Birds	Pomatostomidae	*Pomatostomus temporalis*	Grey-crowned Babbler			31	2002	0	Unknown	10	1993
Birds	Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella			10	2001	0	Unknown	4	1999
Birds	Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike			18	2001	0	Unknown	3	1993
Birds	Campephagidae	*Coracina papuensis*	White-bellied Cuckoo-shrike			1	1987	0	Unknown	1	1993
Birds	Campephagidae	*Lalage sueurii*	White-winged Triller			17	2001	0	Unknown	4	1991
Birds	Pachycephalidae	*Pachycephala rufiventris*	Rufous Whistler			37	2001	0	Unknown	17	1999
Birds	Pachycephalidae	*Colluricincla harmonica*	Grey Shrike-thrush			14	2001	4	1977	8	1999
Birds	Pachycephalidae	*Oreoica gutturalis*	Crested Bellbird			3	1991	0	Unknown	4	1999
Birds	Oriolidae	*Oriolus sagittatus*	Olive-backed Oriole			4	2000	0	Unknown	0	Unknown
Birds	Artamidae	*Artamus personatus*	Masked Woodswallow			2	1991	0	Unknown	2	1991
Birds	Artamidae	*Artamus superciliosus*	White-browed Woodswallow			1	2001	0	Unknown	0	Unknown
Birds	Artamidae	*Artamus cinereus*	Black-faced Woodswallow			18	2001	0	Unknown	9	1999
Birds	Artamidae	*Artamus minor*	Little Woodswallow			7	2001	0	Unknown	0	Unknown
Birds	Artamidae	*Cracticus torquatus*	Grey Butcherbird			1	1987	0	Unknown	0	Unknown
Birds	Artamidae	*Cracticus nigrogularis*	Pied Butcherbird			18	2000	0	Unknown	6	1999
Birds	Artamidae	*Cracticus tibicen*	Australian Magpie			3	1999	0	Unknown	1	1993
Birds	Rhipiduridae	*Rhipidura albiscapa*	Grey Fantail			2	1991	0	Unknown	3	1991
Birds	Rhipiduridae	*Rhipidura leucophrys*	Willie Wagtail			36	2002	0	Unknown	16	1999
Birds	Corvidae	*Corvus orru*	Torresian Crow			24	2001	0	Unknown	3	1993
Birds	Monarchidae	*Myiagra rubecula*	Leaden Flycatcher			2	2000	0	Unknown	1	1999
Birds	Monarchidae	*Myiagra inquieta*	Restless Flycatcher			11	2001	0	Unknown	7	1993
Birds	Monarchidae	*Grallina cyanoleuca*	Magpie-lark			21	2000	0	Unknown	4	1993
Birds	Corcoracidae	*Struthidea cinerea*	Apostlebird			26	2002	0	Unknown	7	1993
Birds	Petroicidae	*Microeca fascinans*	Jacky Winter			11	2001	0	Unknown	5	1999
Birds	Petroicidae	*Melanodryas cucullata picata/westralensis*	Hooded Robin			11	2001	0	Unknown	6	1991
Birds	Megaluridae	*Cincloramphus mathewsi*	Rufous Songlark			2	2001	0	Unknown	0	Unknown
Birds	Hirundinidae	*Petrochelidon nigricans*	Tree Martin			1	1987	0	Unknown	0	Unknown
Birds	Nectariniidae	*Dicaeum hirundinaceum*	Mistletoebird			5	2001	0	Unknown	1	1991
Birds	Estrildidae	*Taeniopygia guttata*	Zebra Finch			4	1989	0	Unknown	1	1993
Birds	Estrildidae	*Taeniopygia bichenovii*	Double-barred Finch			13	2002	0	Unknown	4	1993
Birds	Estrildidae	*Poephila acuticauda*	Long-tailed Finch			18	2002	0	Unknown	4	1999
Birds	Estrildidae	*Poephila personata*	Masked Finch			1	1980	0	Unknown	0	Unknown
Birds	Estrildidae	*Heteromunia pectoralis*	Pictorella Mannikin			2	2001	0	Unknown	1	1993
Mammals	Tachyglossidae	*Tachyglossus aculeatus*	Echidna			1	1994	0	Unknown	1	1993
Mammals	Dasyuridae	*Pseudantechinus mimulus*	Carpentarian Antechinus		VU	0	Unknown	1	1987	0	Unknown

Group	Family Name	Scientific Name	Common Name	NT Status	National Status	#Observations	#Latest Observation Date	#Specimens	#Latest Speciman Date	#Surveys	#Latest Survey Record
Mammals	Dasyuridae	*Planigale maculata*	Common Planigale			2	1987	2	1987	0	Unknown
Mammals	Dasyuridae	*Sminthopsis macroura*	Stripe-faced Dunnart			2	1987	2	1987	0	Unknown
Mammals	Pseudocheiridae	*Petropseudes dahli*	Rock Ringtail			1	1987	0	Unknown	0	Unknown
Mammals	Macropodidae	*Lagorchestes conspicillatus*	Spectacled Hare-wallaby			35	1991	13	1992	4	1991
Mammals	Macropodidae	*Macropus agilis*	Agile Wallaby	N		2	1987	1	1996	0	Unknown
Mammals	Macropodidae	*Macropus robustus*	Common Wallaroo			2	2001	0	Unknown	6	1993
Mammals	Macropodidae	*Macropus rufus*	Red Kangaroo			0	Unknown	0	Unknown	1	1993
Mammals	Macropodidae	*Onychogalea unguifera*	Northern Nailtail Wallaby			13	1991	5	1987	7	1991
Mammals	Pteropodidae	*Pteropus scapulatus*	Little Red Flying-fox			0	Unknown	0	Unknown	1	1993
Mammals	Emballonuridae	*Saccolaimus flaviventris*	Yellow-bellied Sheath-tailed Bat			0	Unknown	1	1959	0	Unknown
Mammals	Emballonuridae	*Taphozous georgianus*	Common Sheath-tailed Bat			0	Unknown	1	1977	0	Unknown
Mammals	Molossidae	*Mormopterus beccarii*	Beccari`s Free-tailed Bat			1	1982	0	Unknown	0	Unknown
Mammals	Vespertilionidae	*Nyctophilus geoffroyi*	Lesser Long-eared Bat			2	1987	2	1987	0	Unknown
Mammals	Vespertilionidae	*Chalinolobus nigrogriseus*	Hoary Wattled Bat			2	1987	3	1987	0	Unknown
Mammals	Vespertilionidae	*Scotorepens greyii*	Little Broad-nosed Bat			1	1982	1	1982	0	Unknown
Mammals	Muridae	*Leggadina lakedownensis*	Northern Short-tailed Mouse			2	1988	5	2001	4	1999
Mammals	Muridae	*Pseudomys delicatulus*	Delicate Mouse			0	Unknown	1	2001	0	Unknown
Mammals	Muridae	*Zyzomys argurus*	Common Rock-rat			0	Unknown	0	Unknown	1	1993
Mammals	Canidae	*Canis lupus*	Dingo / Wild dog	N		1	1987	0	Unknown	1	1993

EX = Extinct EW = Extinct in the Wild ER= Extinct in the NT EN = Endangered
EN/VU = One Endangered subspecies/One Vulnerable subspecies
VU=Vulnerable
VU/- = One or more subspecies vulnerable EN/- = One or more subspecies endangered

Survey = this category refers to data collected using systematic survey methodology
Specimen = this category refers to museum or other records where a specimen has been collected and lodged
Observation = this category refers to all other incidental recordings where systematic methodology may not have been used consistently.

More species info: Go to www.landmanager.org.au/view/index.aspx?id=####
where #### is the ID number from the tables above for the species of interest.

Species listed in the table above were recorded from all the grid cells (red/blue line) shown below that overlap Custom area

Custom area Weeds and Potential Weeds

 Introduced plants recorded in the grid cell(s) in which Custom area occurs and that have been identified as problem weeds in one or more locations in northern Australia. Occurrence based on Northern Territory Government databases.

Family Name	Scientific Name	Common Name	NT Status	National Status	Other Status	#Surveys	Latest Record
Poaceae	*Cenchrus ciliaris*	Buffel Grass			*MP Gr G&M DEU*	0	Unknown
Cucurbitaceae	*Cucumis melo*	Ulcardo Melon			*DEU*	5	1991
Poaceae	*Echinochloa colona*	Awnless Barnyard Grass			*DEU*	2	1991
Fabaceae	*Macroptilium atropurpureum*	Siratro			*C&E*	0	Unknown
Malvaceae	*Malvastrum americanum*	Spiked Malvastrum			*DEU*	1	1988
Plantaginaceae	*Scoparia dulcis*	Bitter Broom			*DEU*	0	Unknown
Malvaceae	*Sida rhombifolia*	Paddy`s Lucerne	*B C*		*MP G&M DEU*	0	Unknown
Malvaceae	*Sida spinosa*	Spiny Sida			*DEU*	0	Unknown
Fabaceae	*Stylosanthes hamata*	Caribbean Stylo			*DEU*	0	Unknown
Poaceae	*Urochloa mosambicensis*	Sabi Grass			*DEU*	0	Unknown
Asteraceae	*Xanthium strumarium*	Noogoora Burr	*B C*		*MP WA1 WA2 WA4 DEU NSW SA*	0	Unknown

Status Codes:
1. NATIONAL STATUS CODES
Alert, Alert List for Environmental Weeds (Please call Exotic Plant Pest Hotline 1800 084 881 if you think you have seen this weed)
Sleeper, National Sleeper Weed
Target,Targeted for eradication. (www.landmanager.com.au/view/index.aspx?id=449837)
WONS, Weeds of National Significance

2. NT STATUS CODES
A, NT Class A Weed (to be eradicated)
B, NT Class B Weed (growth & spread to be controlled)
C, NT Class C Weed (not to be introduced) (www.landmanager.com.au/view/index.aspx?id=449869)

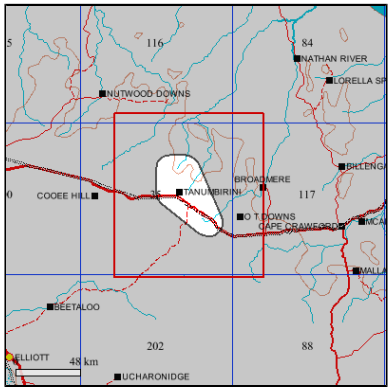
3. OTHER STATUS CODES
C&E, Csurhes, S. & Edwards, R. (1998) Potential Environmental Weeds in Australia. Candidate Species for Preventative Control. Environment Australia, Canberra (www.landmanager.com.au/view/index.aspx?id=394504)
CYP, Draft Cape York Peninsula Pest Management Plan 2006-2011 (www.landmanager.com.au/view/index.aspx?id=371200)
DEU, Plants listed as environmental weeds by the Desert Uplands Strategic Land Resource
Assessment (www.landmanager.com.au/view/index.aspx?id=332123)
G&M, Grice AC, Martin TG. 2005. The Management of Weeds and Their Impact on Biodiversity in the Rangelands. Cooperative Research Centre (CRC) for Australian Weed Management and CSIRO Sustainable Ecosystems. Commonwealth Australia (www.landmanager.com.au/view/index.aspx?id=163572)
Gr, Groves et al. 2003. Weed categories for natural and agricultural ecosystem management. Bureau of
Rural Sciences (www.landmanager.com.au/view/index.aspx?id=388018)
K0, High Priority Weeds not yet established in the Katherine region
K1, High Priority Weeds posing environmental threats in the Katherine region
K2, High Priority Weeds posing existing threats in the Katherine region, as described in the Katherine Regional Weed Management Strategy 2005-2010 (www.landmanager.com.au/view/index.aspx?id=130286)
MP, Northern Territory Parks & Conservation Masterplan (www.landmanager.com.au/view/index.aspx?id=144141)
NAQS, North Australian Quarantine Strategy Target List (www.landmanager.com.au/view/index.aspx?id=449416)
NSW, Declared Noxious Weed in NSW (www.landmanager.com.au/view/index.aspx?id=449983)
Q1, QLD Class 1 Weed (not to be introduced, kept or supplied-
Q2, Class 2 Weed (eradicate where possible, not to be introduced, kept or supplied)
Q3, Qld Class 3 Weed (to be controlled near environmentally sensitive areas- not to be supplied/sold without a permit) (www.landmanager.com.au/view/index.aspx?id=190714)
SA, Declared Plant in South Australia (www.landmanager.com.au/view/index.aspx?id=449996)
WeedsAus, Listed as a significant weed by Weeds Australia (www.landmanager.com.au/view/index.aspx?id=14576)
WA1, WA Weed Class P1 (movement prohibited)
WA2, WA Weed Class P2 (aim to eradicate)

WA3, WA Weed Class P3 (control infestations)
WA4, WA Weed Class P4 (prevent spread)
WA5, WA Weed Class P3 (control infestations on public land) (www.landmanager.com.au/view/index.aspx?id=449884).

Survey = this category refers to data collected using systematic survey methodology
Specimen = this category refers to museum or other records where a specimen has been collected and lodged
Observation = this category refers to all other incidental recordings where systematic methodology may not have been used consistently.

More species info: Go to www.landmanager.org.au/view/index.aspx?id=####
where #### is the ID number from the tables above for the species of interest.

Plants listed in the table above were recorded from all the grid cells shown below (red/blue line) that overlap Custom area



Custom area Introduced Species

Introduced plants in Custom area (ordered alphabetically) that have been identified as introduced species in one or more locations in northern Australia.

Family Name	Scientific Name	Common Name	NT Status	National Status	Other Status	ID	#Surveys (Latest)	Latest Record
Euphorbiaceae	*Euphorbia hirta*	Asthma Plant				289244	0	Unknown
Cucurbitaceae	*Momordica balsamina*	Balsam Apple				291344	0	Unknown
Fabaceae	*Indigofera hirsuta*	Hairy Indigo				290754	0	Unknown
Portulacaceae	*Portulaca pilosa*	Hairy Pigface				292104	0	Unknown
Poaceae	*Eragrostis amabilis var. amabilis*	Lovegrass				.	0	Unknown
Malvaceae	*Melochia pyramidata*	Pyramid Flower				291234	0	Unknown
Poaceae	*Digitaria ciliaris*	Summer Grass				289974	0	Unknown

Survey = this category refers to data collected using systematic survey methodology
Specimen = this category refers to museum or other records where a specimen has been collected and lodged
Observation = this category refers to all other incidental recordings where systematic methodology may not have been used consistently.

Custom area Pest and Potential Pest Animals

 Animals with pest potential recorded in the grid cell(s) in which Custom area occurs. Occurrence based on Northern Territory Government databases.

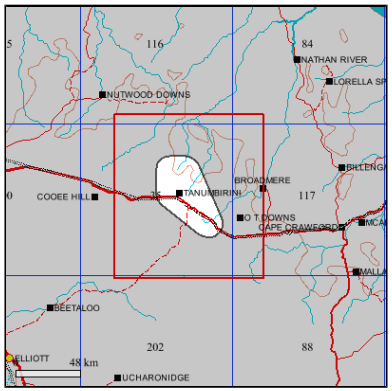
Common Name	Scientific Name	NT Status	National Status	ID	#Observations (Latest)	#Specimens (Latest)	#Surveys (Latest)
Cane Toad	*Rhinella marina*	P	.	183252	1 (2001)	0 (Unknown)	1 (1993)
Red-tailed Black-cockatoo	*Calyptorhynchus banksii macrorhynchus*	N	.	223765	14 (2001)	0 (Unknown)	0 (Unknown)
Agile Wallaby	*Macropus agilis*	N	.	223786	2 (1987)	1 (1996)	0 (Unknown)
Dingo / Wild dog	*Canis lupus*	N	.	183280	1 (1987)	0 (Unknown)	1 (1993)
Horse	*Equus caballus*	P	.	183315	1 (1987)	0 (Unknown)	0 (Unknown)
Cattle	*Bos taurus*	P	.	183266	1 (1987)	0 (Unknown)	2 (1993)

NT STATUS CODES:
Int, Introduced species (all non-prohibited vertebrates, and all other exotic species (www.landmanager.com.au/view/index.aspx?id=280771)
N, Native species with pest potential.
P, Prohibited species (all exotic vertebrates except those listed as non-prohibited (www.landmanager.com.au/view/index.aspx?id=450509)

Survey = this category refers to data collected using systematic survey methodology
Specimen = this category refers to museum or other records where a specimen has been collected and lodged
Observation = this category refers to all other incidental recordings where systematic methodology may not have been used consistently.

More species info: Go to www.landmanager.org.au/view/index.aspx?id=####
where #### is the ID number from the tables above for the species of interest.

Potential pest animals listed in the table above were recorded from all the grid cells shown below (red/blue line) that overlap Custom area



Soils and vegetation graphs and tables refer to area of soils and vegetation only. Fire graphs and tables refer to entire selected area including sea if present. Calculations are derived from map images or vector data, and should be taken as a guide only. Accuracy cannot be guaranteed. For small areas, figures should be rounded to the nearest whole number.

Fire map layers used in these reports have been updated in 2018 so their pixels are aligned to the same grid.

Appendix C: Ecological Assessment Report

Ecology report
2019 exploration program
Santos

www.ecoz.com.au

DOCUMENT CONTROL RECORD

Job	EZ19041
Document ID	176327-33
Author(s)	Aiden Campbell

DOCUMENT HISTORY

Rev	Reviewed by	Approved by	Issued to	Date
1	Felicity Watt	Ray Hall	Santos	27 March 2019
2	Felicity Watt	Ray Hall	Santos	2 April 2019

Recipients are responsible for eliminating all superseded documents in their possession.

EcOz Pty Ltd.
ABN: 81 143 989 039
Winlow House, 3rd Floor
75 Woods Street
DARWIN NT 0800
GPO Box 381, Darwin NT 0800

Telephone: +61 8 8981 1100
Facsimile: +61 8 8981 1102
Email: ecoz@ecoz.com.au
Internet: www.ecoz.com.au

TABLE OF CONTENTS

Tables

Figures

1 INTRODUCTION

Santos is planning their 2019 exploration program within their Exploration Permit area (EP161) on Tanumbirini Station. The exploration works will be regulated through an Environmental Management Plan (EMP) approved by the Department of Environment and Natural Resources (DENR). For the development of the EMP, an assessment of biodiversity values within the exploration area and the 2019 exploration program footprint (project area) is required.

1.1 Purpose and objectives

EcOz Environmental Consultants (EcOz) were engaged to complete a desktop assessment of the biodiversity values within a defined survey area.

The desktop assessment had two objectives:

- To provide sufficient information for Santos to update their EMP for the proposed exploratory drilling program, or develop future EMPs for exploratory drilling or seismic operations.
- To identify biodiversity values within the survey area, such that Santos can incorporate this information into project planning. This includes determining the 'likelihood of occurrence' of threatened species occurring within the survey area.

The desktop assessment is largely desktop based, with some supplementary fieldwork to verify biodiversity values. Fieldwork was limited to the use of existing access tracks within the survey area. The report includes a description of habitat types, and a 'likelihood of occurrence' assessment of threatened species listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*) and NT *Territory Parks and Wildlife Conservation Act* (*TPWC Act*). This information can be used to avoid any adverse impacts on identified biodiversity values and to meet the (DENR) requirements during the update of the EMP or development of future EMPs for exploratory drilling or seismic operations. It is also used to identify specific environmental values which warrant further field based investigation.

The desktop report provided a number of recommendations for Santos to consider when planning any further works. Principally, it was recommended that:

- Undertaking a weed survey at exploratory drilling and/or seismic exploration sites and along access tracks would provide baseline data. This would enable Santos to ensure that activities do not introduce or spread weeds.
- Prior to more intensive works being undertaken, further assessment of habitat for Gouldian Finch and potential impact to this species be undertaken. This would include desktop assessment and on-ground studies and would be assessed in relation to a project area.
- As the identified exploration activities may intersect watercourses that may support sensitive vegetation in the form of riparian vegetation, Santos required the location of any sensitive vegetation to be identified so that potential impact to these communities could be avoided or minimised during exploration.

Given that Santos is planning to undertake the 2019 exploration program, EcOz was engaged to complete surveys targeting these recommendations within the project area. EcOz completed the following two assessments of environmental values within the project area (Section 2.1):

- Ecology report – EP161 work program 2018 (field assessment) (EcOz, 2018a)
- Inacumba bore weed survey and sensitive vegetation assessment (field assessment) (EcOz, 2018b)

Santos has reduced the scope and project area of the 2019 exploration program from the areas identified in the above assessments. The project area has also deviated slightly from the surveyed areas. Additionally,

the Northern Territory Government (NTG) has provided feedback on the draft Environmental Management Plan, and requested clarifications around the assessment of the above listed environmental values.

1.2 Scope

The scope of this report is to consolidate the existing environmental assessments to focus on the two proposed drilling sites and associated activities relevant to the project area.

No new field assessment has been undertaken as part of this report. Data and information detailed in the existing reports has been drawn on, along with available datasets and an updated exploration program layout (provided by Santos). EcOz has reviewed the information presented in the existing reports, addressed any issues raised by Government departmental review, and provided clarity in this report where required.

1.3 Report structure

To achieve the outlined purpose, this report contains three primary sections as outlined below:

- Section 2 – details the project area and the relationship of this area to that which has been surveyed.
- Section 3 – details the methods and results of the desktop assessment undertaken in 2017 and provides recommendations for further work to be undertaken.
- Section 4 – details the outcomes of the field surveys completed for the project area, based on the recommendations of the desktop assessment.

2 PROJECT AREA

The project area includes the following components:

- Two new exploration wells
  - Tanumbirini-2
  - Inacumba-1
- A single 2D seismic profiling line crossing the proposed Tanumbirini-2 well site
- Access tracks
- Borrow pits

The components of the 2019 exploration program are shown in Figure 2-1

Tanumbirini-2 will be located within the existing Tanumbiri-1 lease area, which was drilled in 2014. Exploration activities are expected to occur within the existing disturbance footprint of Tanumbirini-1; however, may extend outside the previously disturbed area, but not more than 500 m from the well head. Inacumba-1 is located south east of Tanumbirini-2, but still within Tanumbirini Station. The proposed well is approximately 12 km north of the Carpentaria Highway. All disturbance for the wells (well drill pad, camps, dams etc.) will be located within a 500 m buffer of the proposed well locations; however, the development will not disturb the entirety of this area.

The proposed 2D seismic profiling line runs in a NNW-SSE direction passing through the proposed Tanumbirini-2 well site. The 2D seismic profiling line extends 5 km each side of the proposed well. The seismic profiling will involve 2-3 small trucks with measurement instruments (hydrophone, geophone or similar) driving along the 2D seismic profiling line and recoding reflected seismic energy originating from an energy source. A tracked bulldozer, with blade up, will precede the seismic trucks to ensure passage. The bulldozer will avoid the majority of trees along the 2D seismic profiling line but may remove obstacles such as termite mounds and understorey thicket, and reduce the approach angle for trucks at watercourse crossings. The bulldozer will remove only what is required for passage of trucks.

Access to Tanumbirini-2 will be along existing station access tracks. These tracks were used for access to the previously drilled Tanumbirini-1. Existing tracks will be used for the majority of the access to Inacumba-1. The access track starts from the Carpentaria Highway and follows a route north-east to the north west side of the proposed Inacumba-1 location. One of two new access tracks would be created from here to reach to Inacumba-1 well location; each of these proposed new access tracks is less than 900 m in length

Two locations for borrow pits have been identified - one location is adjacent to the access track to Inacumba-1 and the other is along the access track to Tanumbirini-2. The borrow pits will be located within one or both of the identified locations, however, only a portion of the identified area will be disturbed for borrow material.

There will also be a laydown area along the access track to Tanumbirini-2.

2.1 Survey area

2.1.1 Desktop assessment

Santos defined a survey area, which incorporated all existing and planned exploration drilling activities including the project area. The survey area, along with the project area, is shown in Figure 2-1.

2.1.2 Field surveys

Two surveys have been completed within the project area; locations and survey tracks are shown in Figure 2-1. Both surveys were undertaken by a team of environmental consultants, all with experience in surveying weeds and vegetation in the Northern Territory. Surveys were completed in August 2018 (Tanumbirini-2 and associated areas) and November 2018 (Inacumba-1 and associated areas).

The area covered by the surveys included:

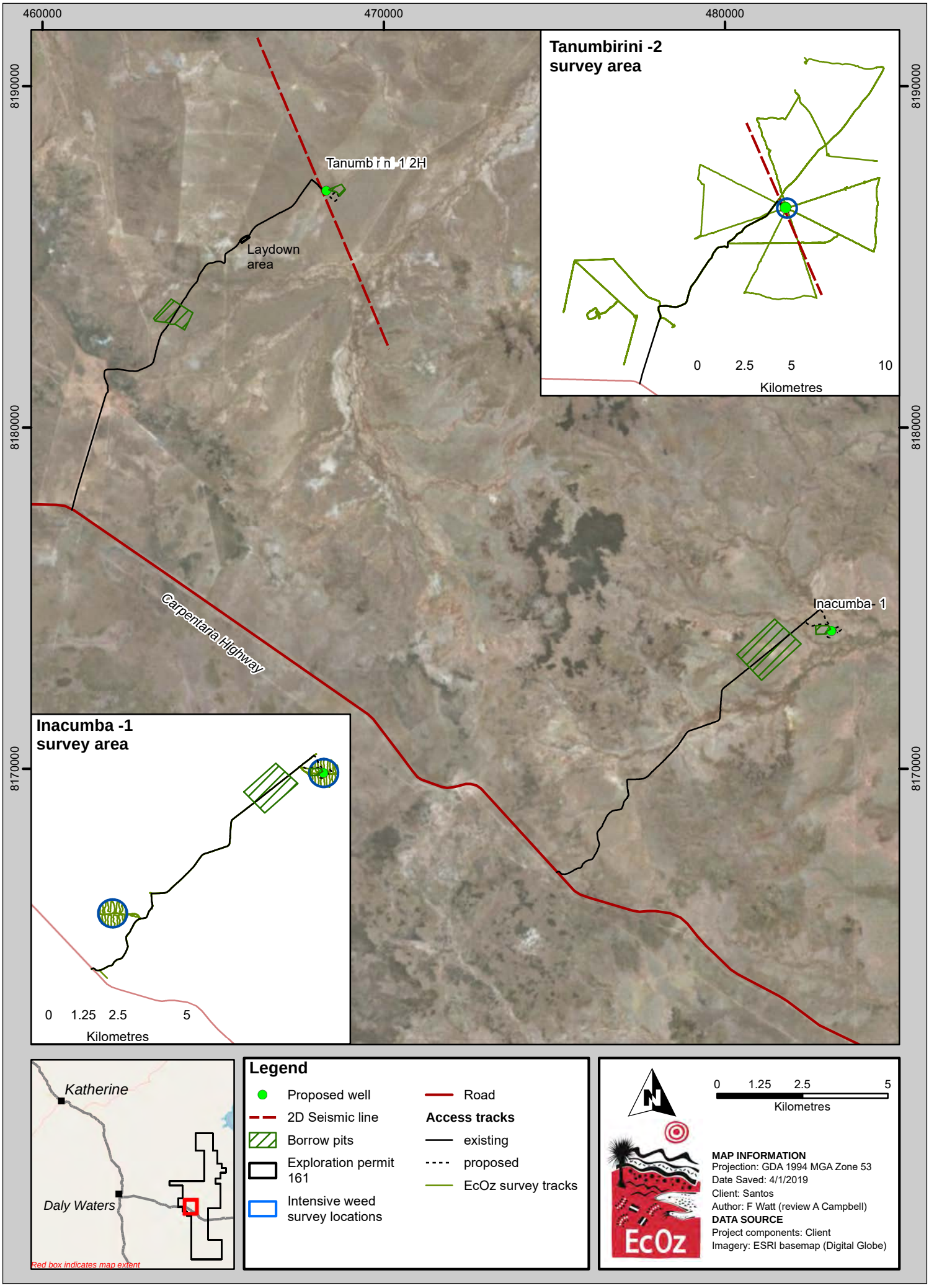
- The 500 m buffer of the proposed Tanumbirini-2 and Inacumba-1 well sites
- Access track to Tanumbirini
- Access track Option 1 and 2 to Inacumba-1
- 40 km of linear transects radiating from Tanumbirini-2

Within each 500 m buffer, a 100 m x 100 m grid was applied over the area. Surveyors walked transects through these areas ensuring they passed through each 100 m x 100 m grid cell once. Field maps of these grid cells were displayed as a moving map on a GPS enabled device for accurate interpretation and field navigation.

Access tracks to the well sites were surveyed by vehicle. Tracks were driven slowly and where a weed species was seen, the vehicle was stopped and data recorded. Stock watering points were also searched for weeds.

Surveyors walked a total of 40 km of linear transects radiating from Tanumbirini-2. There were eight transects in total – each 5 km long. Locations of the transects were based on the previous scope of the exploration program provided by Santos.

The exact location of the 2D seismic line identified in the 2019 exploration program is slightly different to the linear transects surveyed. There is one survey transect in close proximity to the proposed 2D seismic line; the landforms and vegetation through which the updated 2D seismic line passes are consistent with those of this survey transect. The location of the borrow pits have not been surveyed.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19041 - Santos EP161 EMP aspects\01 Project Files\Figure 2-1. 2019 exploration program.mxd

Figure 2-1. Map of project area and survey area

3 DESKTOP ASSESSMENT

3.1 Environmental context

3.1.1 Climate

The survey area experiences two distinct seasons - a dry season with little/no rainfall between approximately May to October, and a monsoonal wet season from November to March. The nearest weather station with Bureau of Meteorology regional climatic data is the Daly Waters' airport weather station, which lies 120 km to the east of the survey area.

Figure 3-1 provides a summary of climate information; January and February are the wettest months, both with over 150 mm rainfall on average per year. June and July are the coolest months, with an average maximum of 29°C, contrasting with an average maximum of 38°C in the hottest month of November.

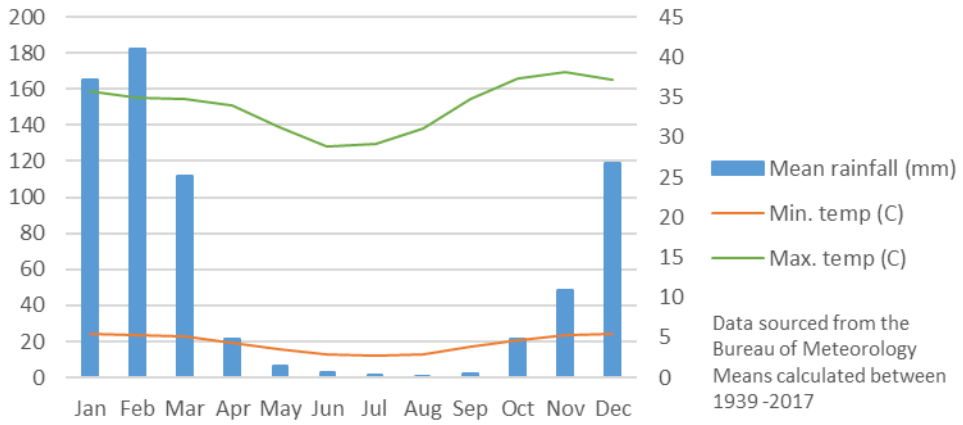
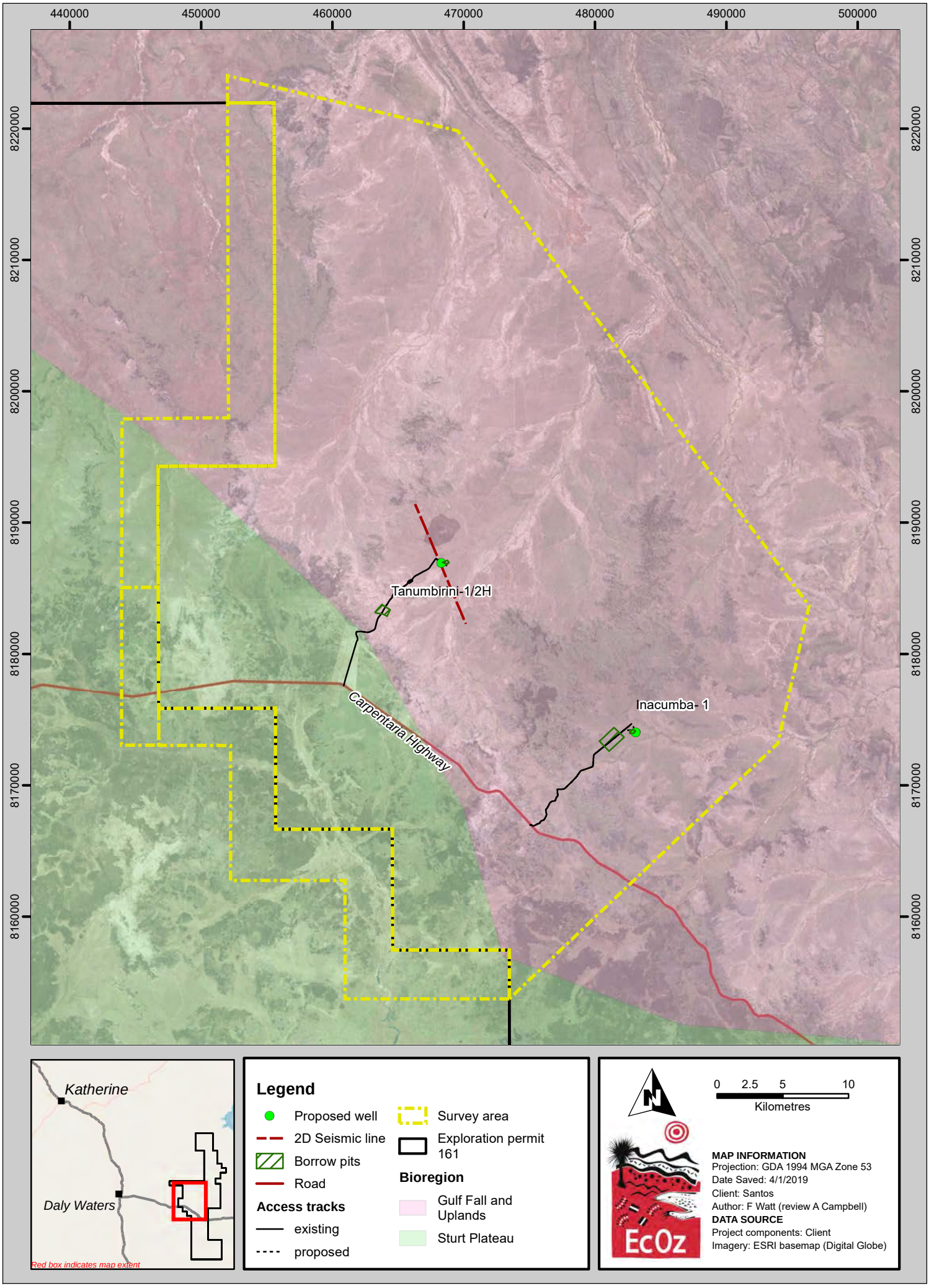


Figure 3-1. Average monthly temperature and rainfall Daly Waters airstrip, Northern Territory

3.1.2 Bioregions

The Interim Biogeographic Regionalisation for Australia divides Australia into geographically-distinct units – called *bioregions* – of broadly similar climate, landform, geology and biodiversity (Baker et al. 2005). The survey area covers the following two bioregions (see Figure 3-2):

- The south-western portion of the survey area falls within the Sturt Plateau bioregion, a gently undulating plain. Vegetation is mostly *Eucalyptus dichromophloia* woodlands with spinifex understorey. There are also large areas of Lancewood thickets (*Acacia shirleyi*), Bullwaddy Woodlands (*Macropteranthes kekwickii*) and open *Eucalyptus* woodlands to the north.
- Approximately two-thirds of the survey area (the north-east) falls within the Gulf Fall and Uplands bioregion, which is comprised of scattered low steep hills on skeletal soils. Vegetation is mostly *Eucalyptus tetrodonta* and *Corymbia dichromophloia* woodland with a spinifex understorey, and also *Eucalyptus tectifica* with a tussock grass understorey.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19041 - Santos EP161 EMP aspects\01 Project Files\Figure 3-2. Map showing survey area, project area and bioregions.mxd

Figure3-2. Map showing bioregions within survey area

3.2 Methods

The assessment of biodiversity values primarily utilised government databases to identify values within the survey area. This was augmented by an on-ground survey to verify the land system, identify important habitat for threatened species, and look for any other biodiversity values on site. This section of the report describes the methods used for both the desktop and field surveys.

3.2.1 Land systems

A land system is 'an area or group of areas throughout which there is a recurring pattern of topography, soils and vegetation' (Christian & Stewart 1968). This recurrent composition gives each land system a characteristic pattern which can be mapped from aerial imagery.

Land systems within the survey area were determined using the *Land Systems of the Northern Part of the NT (1:250,000)* dataset (DENR 2008) and the *Land Systems of the Southern Part of the NT (1: 1,000,000)* dataset (DENR 2011). The datasets are managed by the Northern Territory Government.

Land systems were verified through on-ground assessment of land form and vegetation characteristics. This land systems' mapping has then been used to assist in the determination of the presence of suitable habitat for threatened species.

3.2.2 Vegetation

Vegetation within the survey area was determined using the *National Vegetation Information System 4.2* (DEE 2016) spatial dataset, which is maintained by the Commonwealth Department of Environment and Energy (DEE).

3.2.3 Sensitive vegetation communities

Sensitive vegetation types are those considered to be significant under the NT *Land Clearing Guidelines* (NRETAS 2010), such as monsoon forest, riparian vegetation, mangrove, groundwater-dependent ecosystems, and wetlands. These areas are either unique to the region and/or have high biodiversity values. A review of existing vegetation mapping, land systems, and aerial imagery indicated that two sensitive vegetation types could occur within the survey area – riparian vegetation and wetlands.

Ecologists visited areas of potential sensitive vegetation communities during surveys and assessed whether sensitive vegetation communities were present.

3.2.4 Watercourses, wetlands and waterholes

The major watercourses, lakes, dams and wetlands within the survey area were identified using Bureau of Meteorology geo-fabric and aerial imagery. The *Directory of Important Wetlands in Australia* – a database of nationally-important wetlands, compiled in cooperation with conservation agencies and other resource managers in all jurisdictions – was queried to identify wetlands within the survey area.

All accessible watercourses were assessed during on-ground biodiversity values assessment. An assessment of the stream order at each watercourse survey site was made, along with identification of the vegetation community and a description of the watercourse profile. Photos were taken at each site.

Permanent waterholes are important habitat for biodiversity. Waterholes which are potentially permanent through the dry season were identified from aerial imagery. Site visits were undertaken where access to permanent waterholes was possible. Characterisation of potential habitat value was undertaken at these sites.

3.2.5 Threatened species

A 'likelihood of occurrence' assessment was conducted to determine which threatened species have potential to occur within the survey area. This is a preliminary assessment and, although augmented by a field visit, may require further field work for future approvals.

The International Union for the Conservation of Nature (IUCN) nominates a set of criteria used to identify species at risk of extinction which is used to define categories of risk (Figure 3-3). These criteria and categories are used by both the NT Government to identify threatened species listed under the *TPWC Act*, and by the Commonwealth Government to identify national threatened species under the *EPBC Act*. The focus of this report is species that are listed as threatened under either the *TPWC Act* or the *EPBC Act* (or both) – i.e. species that are listed as Vulnerable, Endangered, or Critically Endangered.

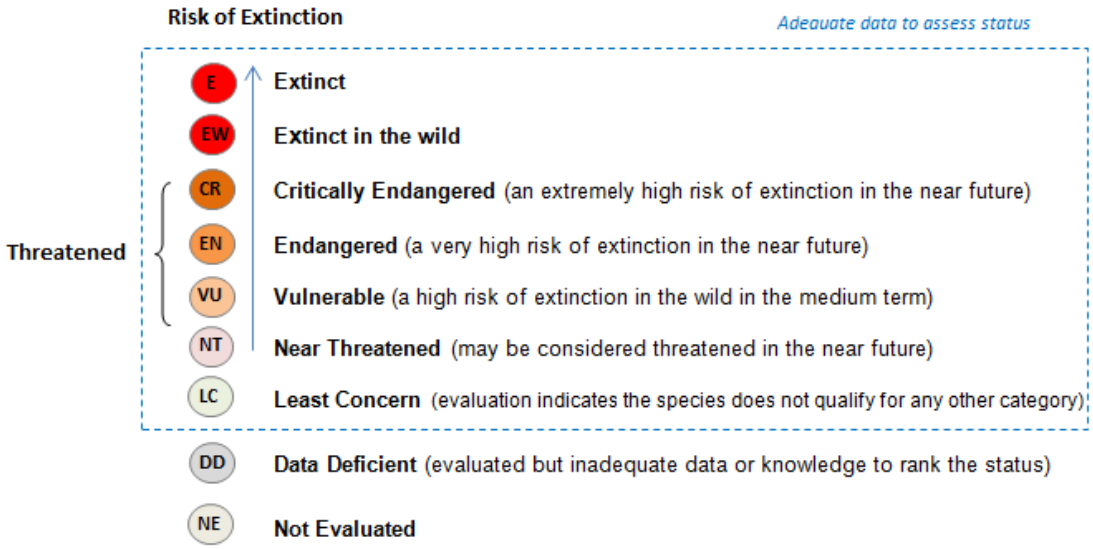


Figure 3-3. IUCN list categories of risk for threatened species

The following datasets were searched to generate a list of potential threatened species:

- **EPBC Protected Matters Search Tool (PMST).** An online database managed by DEE which interrogates existing flora and fauna records and uses predictive habitat modelling to return a list of species which may occur in the defined area and a likelihood of each of these threatened and migratory species occurring. This dataset was interrogated within a 100 km buffer of the survey area. The results of the PMST search are provided in Appendix A.
- **Northern Territory Flora & Fauna Atlas.** A database maintained by the Department of Environment and Natural Resources (DENR) of point records of fauna and flora species identified through biological surveys (either as validated incidental observations or voucher specimens) conducted in the NT under a Wildlife Permit. The updated dataset was obtained by EcOz from the DENR on 17 October 2016. The dataset was spatially interrogated using the boundaries of the Gulf Fall and Uplands, and Sturt Plateau bioregions.

For each of the species returned from the database searches, the likelihood of it occurring within the survey area was assessed based on habitat requirements, distribution, and the number and dates of proximate records. On-ground habitat assessment was also used to assist the assessment.

In this assessment, the likelihood of a species occurring is ranked as none, low, medium, and high. In the context of this report, this means:

- **None** – There is no likelihood of this species occurring within the survey area.

- **Low** – The survey area occurs outside of the core distribution for the species and there is no or only marginally-suitable habitat. Some vagrant records may exist.
- **Medium** – There is suitable habitat within the survey area but records are either old, infrequent or some distance from the survey area.
- **High** – There is suitable habitat within the survey area and records are proximate and recent.

3.2.6 Migratory and marine species

Listed migratory and marine species are protected in Australia due to Australia's obligations under international conventions.

Migratory and marine species, which potentially occur within the survey area, were identified through the PMST database search (100 km buffer around the survey area). This search area includes a portion of coastline and marine habitat in the Gulf of Carpentaria. This inclusion expands the list of identified species. A 'likelihood of occurrence' assessment for these species was done following the same procedure as for threatened species.

3.3 Results

3.3.1 Land condition

Pastoralism

The survey area is located within Tanumbirini Station, an active pastoral property. Impact across the survey area was evident during field surveys. Cattle impact consisted of grazing to understorey species and trampling impacts around watercourses – this trampling has led to erosion around these watercourses.

Weeds and pests

NT listed weeds identified within the region include Prickly Acacia (*Acacia nilotica*), Bellyache Bush (*Jatropha gossypiifolia*), Spinyhead Sida (*Sida acuta*), Noogoora Burr (*Xanthium pungens / X. strumarium*), Parkinsonia (*Parkinsonia aculeata*), Mesquite (*Prosopis spp*.), Khaki Weed (*Alternanthera pungens*), Rubber Bush (*Calotropis procera*), and Hyptis (*Hyptis suaveolens*) (DLRM 2017). Mexican poppy (*Argemone ochroleuca*) occurs in some catchments including the McArthur River, and Rubber Vine (*Cryptostegia grandiflora*) is a potential threat in this region.

The Katherine Regional Weed Management Plan 2015-2020 (Weed Management Plan) (DLRM 2015) includes the survey area. The Weed Management Plan identifies priority weeds within the region (Table 3-1).

Table 3-1. Priority weeds within the Katherine Region Weed Management Plan

Species	Class	Weed of National Significance (WoNS)
Mesquite - *Prosopis spp.*	A/C	Y
Prickly acacia - *Vachellia nilotica*	A/C	Y
Parkinsonia - *Parkinsonia aculeata*	B/C	Y
Chinee Apple - *Ziziphus mauritiana*	A/C	-
Mimosa - *Mimosa pigra*	A/C	Y
Bellyache Bush - *Jatropha gossypiifolia*	A/C	Y
Gamba Grass - *Andropogon gayanus*	A/C	Y
Neem - *Azadirachta indica*	B/C	-
Grader grass - *Themeda quadrivalvis*	B/C	Y
Snake weed - *Stachytarpheta spp.*	B/C	-
Devils Claw - *Martynia annua*	A/C	-

There are a number of records of Parkinsonia, Gamba Grass and Bellyache Bush near to the survey area. Hyptis was observed within the survey area.

Weed distribution is often related to environmental disturbances caused by the construction of roads and tracks, cattle grazing and feral animals. Weeds are most prevalent on land under pastoral lease, with infestations generally concentrated around infrastructure such as water points, fence lines and tracks, and also along the banks of watercourses where cattle and feral animals tend to congregate.

Pests that may occur within the survey area include Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo, Donkey and Cane Toads (DoE 2017). Donkeys and Pigs were observed during field surveys.

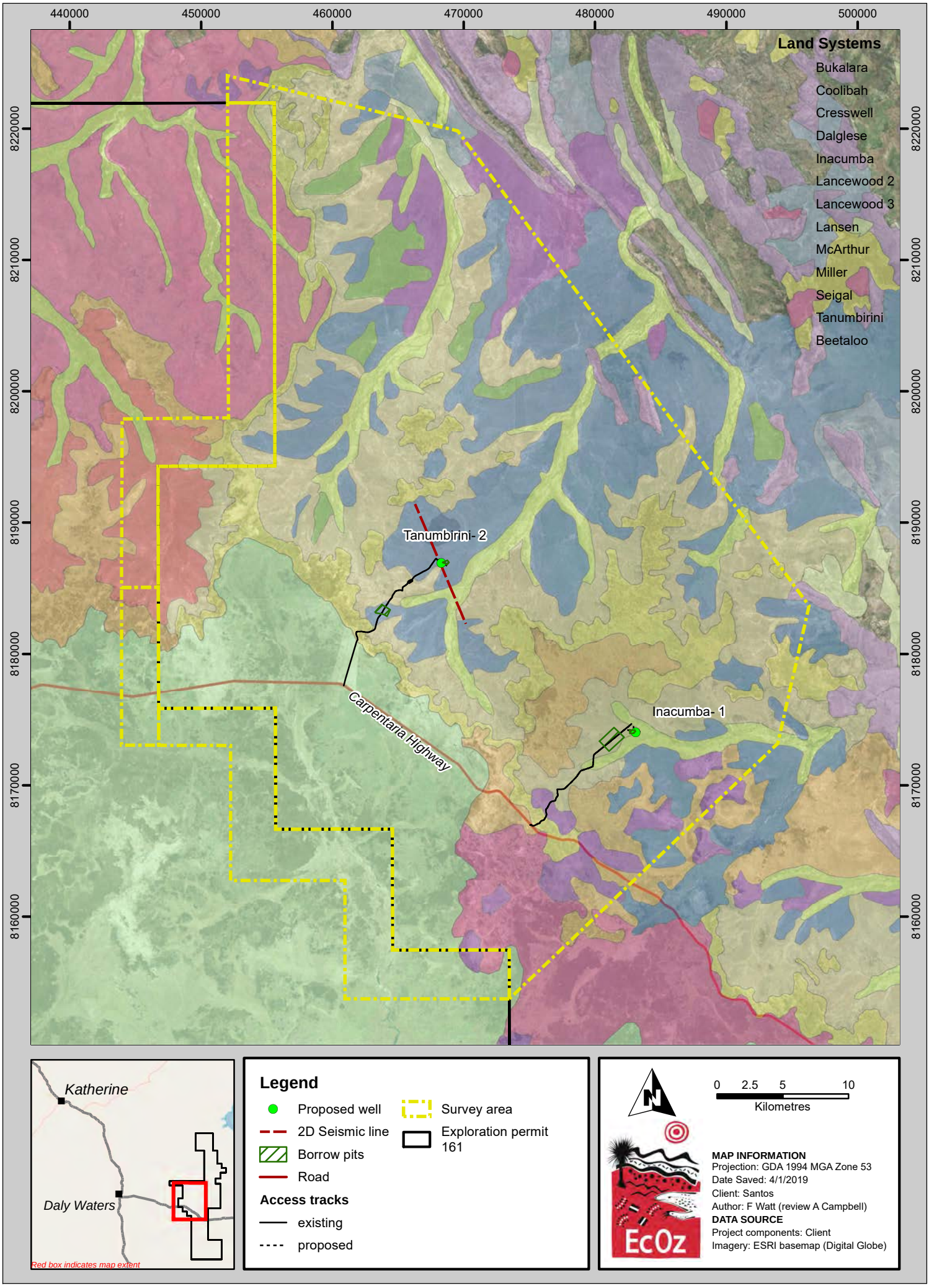
3.3.2 Land systems

There are 13 land systems mapped within the survey area (Table 3-2 and Figure 3-4). The land systems within the survey area consist primarily of lateritic plains, lateritic plateau, alluvial plains, and sandstone plains and rises. The landform and vegetation characteristics at each of the survey sites corresponded to the mapped land system.

Table 3-2. Land systems within the survey area (as per Lynch & Wilson 1998)

Name	Landform	Soils	Main vegetation*
Beetaloo (BE)	Plains and rises on weathered sedimentary rocks	Red clayey sands, red earths and texture contrast soils	*Acacia shirleyi* Lancewood forest
Dalglese (Tcd)	Plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products	Sandy and earth soils	Mid-high open woodland of *Eucalyptus pruinosa, Corymbia terminalis, Erythrophleum chlorostachys, Melaleuca citrolens, Lysiphyllum cunninghamii* over sparse grass cover (*Chrysopogon fallax, Sehima nervosum, Heteropogon contortus*)
Inacumba (Lwi)	Plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products	Sandy and earth soils	Mid-high open woodland of *C. dichromophloia, E. miniata, E. tetrodonta, Corymbia ferruginea, E. leucophloia* with isolated stands of *A. shirleyi* on steeper slopes over *Eriachne spp, Chrysopogon fallax, Triodia pungens*
Lancewood 2 (Lwl)	Crenulate escarpments, rugged low hills and gently undulating lower slopes on actively eroding, ferruginised Lower Cretaceous sediments (claystone and laterite)	Grey and Brown Vertosols and Leptic Rudosols; shallow soils with rock outcrop	Mid high open woodland of *E. pruinosa* with areas of mixed grasslands, *Acacia shirleyi* on cliffs and slopes
Lancewood 3 (Lwl)			
McArthur (Tam)	Broad or narrow fluvial corridors conducting regional drainage across various Land Systems towards the coast	Aquic Vertosols, Red and Yellow Kandosols and Orthic Tenosols; sandy, silty and clay soils on Quaternary alluvium	Mid high open woodland of *E. microtheca* with some *Corymbia papuana* and *Corymbia polycarpa,* tall fringing riparian vegetation often including *Melaleuca* spp.
Miller (Tcm)	Level plains to gently undulating clay plains	Cracking clay soils	Mid-high open woodland of *E. pruinosa* over *Eulalia fulva, Chrysopogon fallax, Aristida inaequiglumis*
Tanumbirini (Tct)	Plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products	Sandy and earth soils	Mid-high open woodland of *Eucalyptus chlorophylla, Erythrophleum chlorostachys, Corymbia polycarpa, Eucalyptus tetrodonta, Terminalia grandifolia* over *Chrysopogon fallax, Eulalia fulva, Triodia pungens*
Bukalara (Asb)	Rugged rocky plateaux and steep linear ridges on massive sandstones such as the Bukalara and Kombolgie Sandstones	Leptic Rudosols; shallow sandy soils and rock outcrop	Mid high open woodland of *Eucalyptus dichromophloia* with *Eucalyptus miniata, Eucalyptus tetrodonta* and *Eucalyptus leucophloia,* some *Eucalyptus kombolgiensis*
Coolibah (Tac)	Level to gently undulating plains on unconsolidated, transported materials, rarely sedentary	Aquic Vertosols; sandy, silty and clay soils on Quaternary alluvium	Mid high open woodland of *Eucalyptus microtheca* with some *Excoecaria parvifolia* and Corymbia *papuana*
Cresswell (Lwc)	Erosionally stable, gently undulating lateritic plains and rises	Leptic Rudosols, Leptic Tenosols, Red and Yellow Kandosols; sandy and earth soils	Mid high open woodland of *C. dichromophloia* and *Corymbia bleeseri* with isolated stands of *Acacia shirleyi*

Name	Landform	Soils	Main vegetation*
Lansen (All)	Long, low, often terraced rises with linear outcrop on prominently bedded sandstones	Leptic Rudosols; commonly shallow soils with surface stone and rock outcrop	Mid high open woodland of *E. ferruginea* with some *Lysiphyllum cunninghamii*
Seigal (Als)	Gently undulating to undulating rises with abundant, often linear rocky outcrops	Leptic Rudosols and Leptic Tenosols; often linear rocky outcrops and shallow sandy soils	Mid high open woodland of *Eucalyptus miniata, Eucalyptus tetrodonta* and *Eucalyptus ferruginea* with *Corymbia. dichromophloia* and *Eucalyptus leucophloia*



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19041 - Santos EP161 EMP aspects\01 Project Files\Figure 3-4. Map land systems intersected by the survey and project areas.mxd

Figure 3-4. Map of Land Systems within the survey area

3.3.3 Vegetation

The dominant vegetation types within the survey area are *Eucalyptus* and *Corymbia* communities (in the plains and undulating hills), *Acacia* woodlands/forests, and *Melaleuca* communities (within drainages lowlands, and depressions), Lancewood woodland/forests and Bulwaddy woodlands.

Although not indicated on the NVIS mapping, sections of the survey area were identified during the field survey as tussock grasslands on lateritic plains or alluvial plains. These areas were too small to be picked up at the NVIS scale. These grasslands were surrounded by either *Eucalyptus* or *Melaleuca* woodlands.

Vegetation exhibited impacts from cattle. Understorey grass species showed extensive impact from cattle grazing. Trampling and impacts to the soil surface was also evident.

Eucalyptus woodlands containing *Eucalyptus leucophloia,* which occurs on rises (particularly within the lateritic plateau land systems), may provide habitat for Gouldian Finch (see Section 5). This species is one of the preferred nesting trees.

Photos of typical vegetation communities within the survey area are shown below.

Eucalyptus woodlands with tussock understorey

Eucalyptus woodlands with hummock understorey

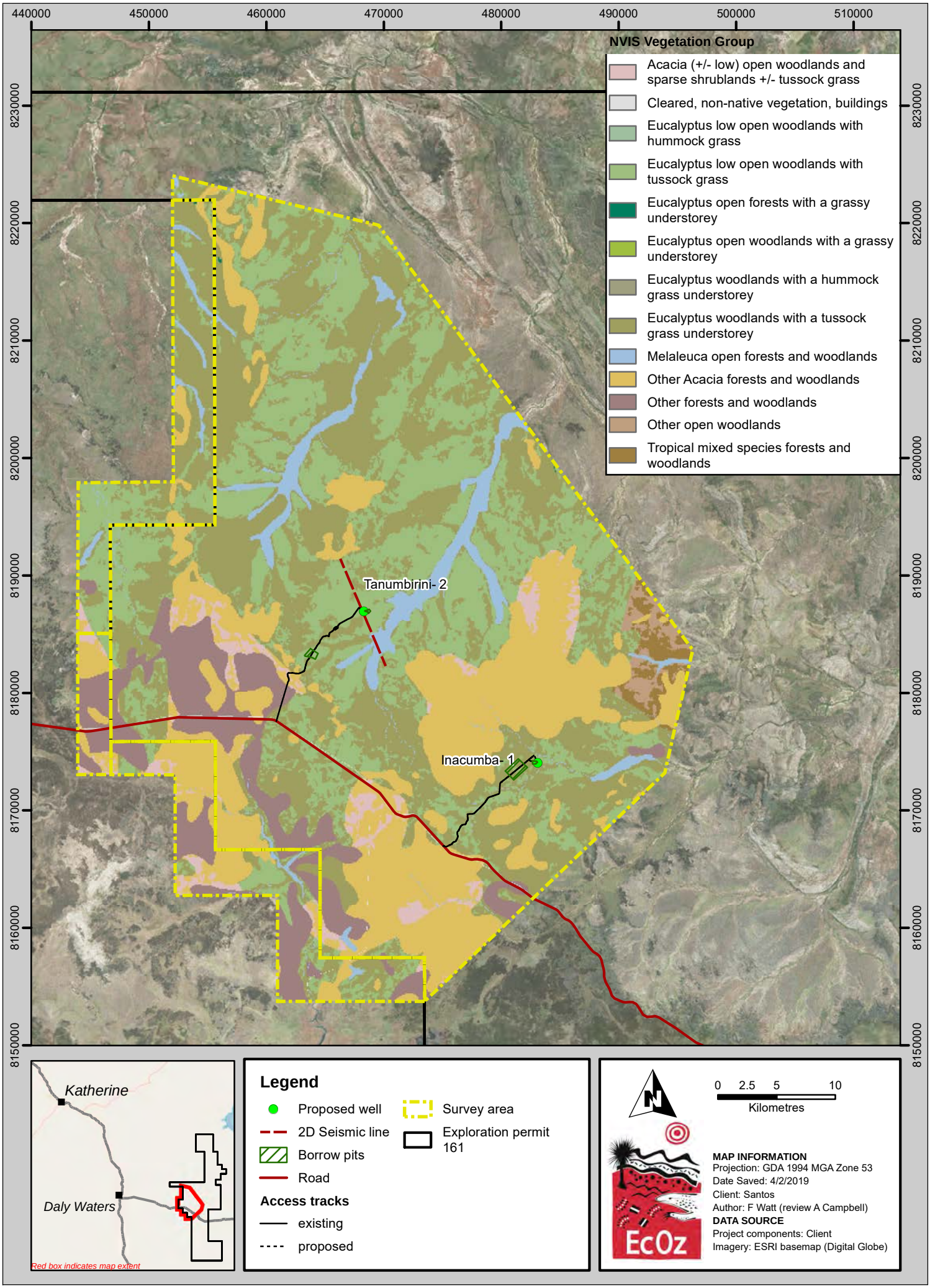
Corymbia woodlands

Tussock grassland

Melaleuca woodland

Acacia woodland/forest

Bullwaddy woodland



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19041 - Santos EP161 EMP aspects\01 Project Files\Figure 3-5. Map showing NVIS vegetation within the survey and project areas.mxd

Figure 3-5. Map showing NVIS vegetation within the survey area

3.3.4 Sensitive vegetation communities

There was a single sensitive vegetation community type identified within the survey area.

Riparian vegetation occurs along freshwater waterways (ephemeral or permanent). It is a distinct, closed forest community that creates suitable conditions for a range of species (terrestrial and aquatic) by providing shade (DLRM 2013). It covers a relatively small land area and provides unique habitat features and dry season refuge for a range of native fauna species (DLRM 2013).

Six riparian sites were visited during field survey (this is a representative set of sites within the survey area). Typical riparian vegetation in the region consists of *Eucalyptus* and *Melaleuca* communities with tussock grass understoreys. Riparian vegetation within the survey area was confined to the banks of the watercourse and did not extend far into the surrounding country.

Like other areas within the survey area, riparian vegetation exhibited impacts from cattle. Erosion from cattle trampling was evident on the banks of all watercourses visited. Understorey grass species showed extensive impact from cattle grazing; this has likely exacerbated the erosion along the watercourse banks.

Figure 3-6. Photos showing typical riparian vegetation within the survey area

3.3.5 Watercourses, wetlands and waterholes

There are no wetlands of international or national significance within the survey area.

There are two ephemeral (seasonal) watercourses within the survey area – Lagoon Creek, and Tanumbirini Creek. Newcastle Creek is also within the survey area. These watercourses are associated with the McArthur land system.

Three permanent waterholes were visited during field survey (those which were accessible using existing access tracks). One of these permanent waterholes, 'Rocky Hole', is used for pastoral operations (water is pumped from this site and it is evidently visited by stock). Rocky Hole is a relatively large waterhole with a sandstone cliff to the upstream end. It is fringed with *Melaleuca sp.* with a tussock grass understorey. Multiple Freshwater Crocodiles (*Crocodylus johnstonii*) were observed within the waterhole, and numerous bird species were utilising this environment.

The second waterhole was a large, elongate waterhole which appeared to have a similar profile to the surrounding watercourse. The waterhole is located between two bands of quartz sandstone outcropping to the north-east of the survey area. The third waterhole was smaller and was surrounded by flat plains. This waterhole was on the same watercourse as Rocky Hole, further upstream.

Aerial imagery indicates that there are multiple other waterholes in the survey area; however, access to these was not possible.

3.3.6 Threatened species

There are records for 31 threatened species (Commonwealth and/or Northern Territory-listed) within the two relevant bioregions – 30 fauna and one flora species. It should be noted that the project occurs within Beetaloo Basin, an area which has very few records of threatened species compared to the savanna woodland habitats to the north and in the arid lands to the south (DEWHA 2009).

The key points of the 'likelihood of occurrence' assessment are summarised below and in Table 3-3, and detailed in Appendix B.

- No species were ranked as having a 'high' chance of occurring within the survey area.
- Four species were ranked as having a 'medium' chance of occurring within the survey area.
- Thirteen species were ranked as having a 'low' chance of occurring within the survey area
- Fifteen species were considered to not occur within the survey area.

Only species which have a medium likelihood of occurring within the survey area are considered further in this report.

Table 3-3. Threatened species 'Likelihood of Occurrence' assessment (summary)

Likelihood	Common name	Scientific name	Group	Status	
				NT	Cth
Medium	Gouldian Finch	*Erythrura gouldiae*	Bird	VU	EN
	Grey Falcon	*Falco hypoleucos*	Bird	VU	-
	Crested Shrike-tit (northern subspecies)	*Falcunculus frontatus whitei*	Bird	-	VU
	Mertens' Water Monitor	*Vananus mertensi*	Reptile	VU	-
Low	Red Goshawk	*Erythrotriorchis radiata*	Bird	VU	VU
	Partridge Pigeon (eastern subspecies)	*Geophaps smithii smithii*	Bird	VU	VU
	Painted Honeyeater	*Grantiella picta*	Bird	VU	VU
	Australian Painted Snipe	*Rostratula (benghalensis) australis*	Bird	VU	EN
	Masked Owl (northern subspecies)	*Tyto novaehollandiae kimberli*	Bird	VU	VU
	Brush-tailed Rabbit-Rat	*Conilurus penicillatus*	Mammal	EN	VU
	Ghost Bat	*Macroderma gigas*	Mammal	-	VU
	Carpentarian Antechinus	*Pseudantechinus mimulus*	Mammal	-	VU
	Pale Field-rat	*Rattus tunneyi*	Mammal	VU	-
	Bare-rumped Sheathtail Bat	*Saccolaimus saccolaimus (nudicluniatus)*	Mammal	-	VU
	Plains Death Adder	*Acanthophis hawkei*	Reptile	VU	VU
	Mitchell's Water Monitor	*Varanus mitchelli*	Reptile	VU	-
	Floodplain Monitor	*Varanus panoptes*	Reptile	VU	-

Key: EN – Endangered, VU – Vulnerable

Gouldian Finch, Grey Falcon, Crested Shrike-tit and Mertens' Water Monitor were considered to have a medium likelihood of occurrence. Two of these species (Grey Falcon and Crested Shrike-tit) have broad ranges and utilise woodland habitat that is common to the region. As such, it is considered that an exploratory drilling program or seismic exploration program is unlikely to have any significant impact on these species or their habitat.

There is a single record of Merten's Water Monitor (record date 1993) close to the project area, but south of the Carpentaria Highway. The species is widespread across the NT, occupying all of the Top End river systems (Ward et al. 2006). It occupies edges of freshwater watercourses and lagoons, but is seldom seen far from water (Christian 2004). Any impact from an exploratory drilling or seismic program would only occur if there was significant disturbance to riparian habitat where the species occurred; this is not proposed.

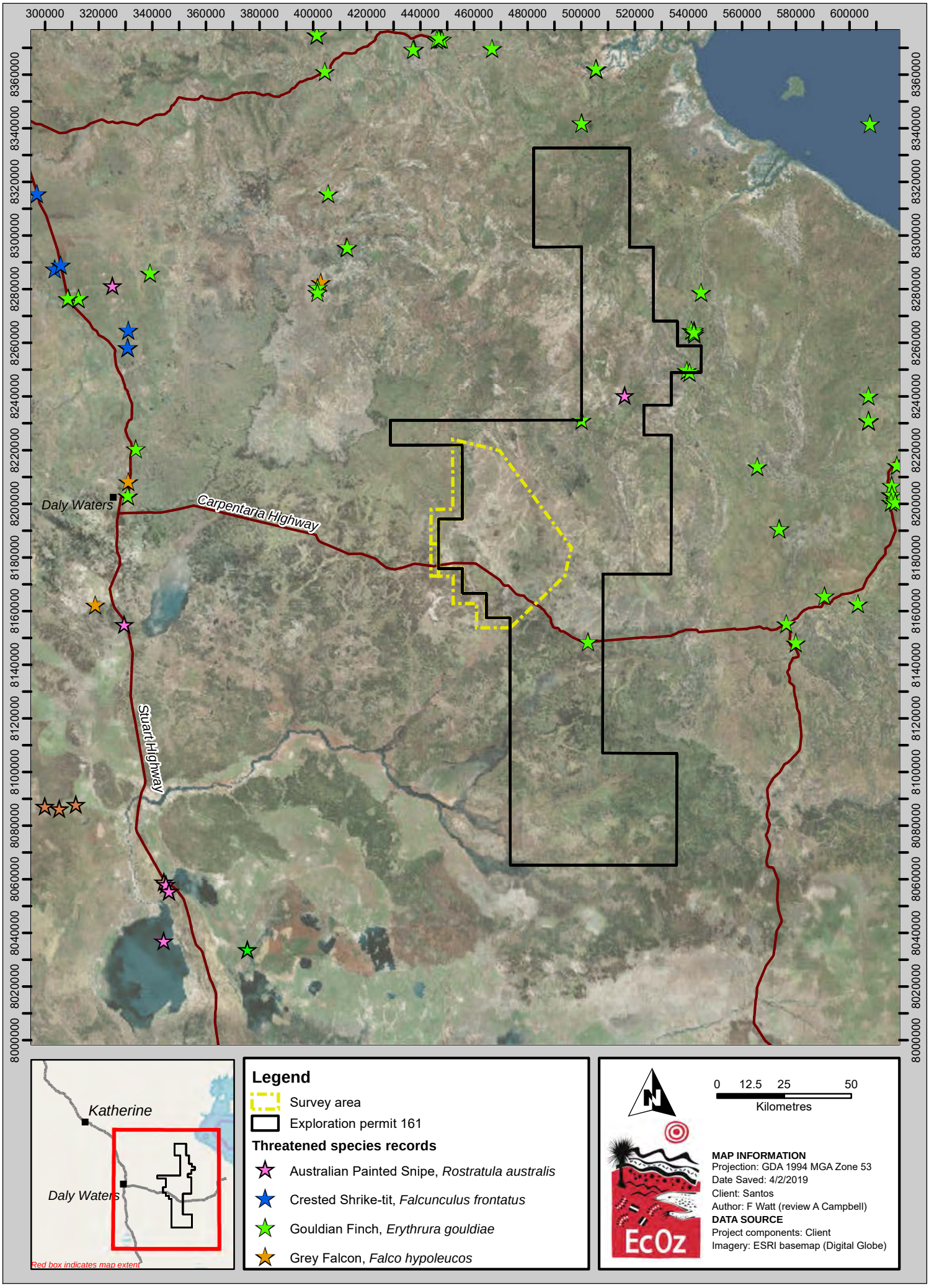
The Gouldian Finch has more specific habitat requirements. In particular, in the late wet season and entire dry season (February to October) the species occurs in rocky hills that support Eucalyptus species commonly referred to as Snappy Gum or Salmon Gum (which provide suitable hollows for nesting purposes). *Eucalyptus leucophloia* is one of these preferred nesting species. Nest sites are between two and four kilometres from small permanent waterholes or springs (O'Malley et al. 2006). Gouldian Finch feed on annual spear grasses and native sorghum (i.e. *Sorghum* species) during this period.

The field survey identified a number of sites where *E. leucophloia* was present. These sites were on hilled areas within the survey area. These sites correlated to land systems that had an identified landform of lateritic plateau. The understorey species consisted of hummock, tussock or a mixture of hummock/tussock grass species. In a number of areas, the habitat was considered long unburnt (there were large spinifex

hummocks) and there were considerable hollows that, through preliminary assessment, appeared to be suitable nesting locations.

From the field observations and the available land system mapping of the survey area, Gouldian Finch breeding habitat may occur within the following land systems – Lancewood 2[2], Inacumba and Bukalara. There are areas of each of these land systems in the survey area.

[2] Although *Eucalyptus leucophloia* is not associated with the Lancewood 2 land system in Table 3-2, the field survey identified numerous areas of this within the land system.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19041 - Santos EP161 EMP aspects\01 Project Files\Figure 3-7. Map of proximate records for medium likelihood threatened species.mxd

Figure 3-7. Map of proximate records for medium likelihood threatened species

3.3.7 Migratory species

A Protected Matters Search Report identified 16 EPBC-listed migratory species as potentially occurring within the survey area. Three of the migratory species were identified by a Likelihood of Occurrence assessment as having a medium likelihood of occurrence in the survey area, and a further eight had a low likelihood of occurrence, the remaining five were assessed as having no likelihood of occurring within the survey area.

When assessing if a project will significantly impact upon a migratory species, the key considerations under the *EPBC Significant Impact Guidelines 1.1* (DOE 2013) are whether an important habitat for a migratory species or an ecologically-significant population of a migratory species is involved. Although the migratory species in question have very different habitats and ecologies, they are all similar in that the project area neither represents important habitat for them, nor are ecologically-significant populations likely to be present.

Table 3-4. Migratory species 'likelihood of occurrence' assessment (summary)

Likelihood	Common name	Scientific name	Group
Medium	Fork-tailed Swift	*Apus pacificus*	Migratory marine bird
	Oriental Plover	*Charadrius veredus*	Migratory wetland species
	Oriental Pratincole	*Glareola maldivarum*	Migratory wetland species
Low	Oriental Cuckoo	*Cuculus optatus*	Migratory marine species
	Barn Swallow	*Hirundo rustica*	Migratory terrestrial species
	Red-rumped Swallow	*Cecropis daurica*	Migratory terrestrial species
	Grey Wagtail	*Motacilla cinerea*	Migratory terrestrial species
	Yellow Wagtail	*Motacilla flava*	Migratory terrestrial species
	Common Sandpiper	*Actitis hypoleucos*	Migratory wetland species
	Sharp-tailed Sandpiper	*Calidris acuminata*	Migratory wetland species
	Pectoral Sandpiper	*Calidris melanotos*	Migratory wetland species

None of the three species identified as having a medium likelihood of occurring within the survey area are expected to be impacted by an exploratory drilling program. The Fork-tailed Swift would only be found above the survey area as it is an exclusively aerial species. The Oriental Plover and the Oriental Pratincole potentially occur within the survey area, however, these species are unlikely to be impacted by an exploratory drilling program or seismic exploration program as the area of disturbance will be small and the species' preferred habitat covers large areas.

3.3.8 Avifauna observations

Thirty-three species were observed within the survey area during field surveys (August 2017) – see Table 3-5. Avian species were recorded in all land systems; however, the majority of records come from areas surrounding the waterholes/watercourses, and the Eucalypt/Corymbia woodlands. No threatened species were observed.

Table 3-5. List of avian species observed during field surveys

Double-barred Finch	Brown Honeyeater	Black Falcon
Peaceful Dove	Nankeen Night Heron	Australian Pratincole
Black-faced Wood-swallow	Straw-necked Ibis	Red-tailed Black-Cockatoo
Nankeen Kestrel	Great Bowerbird	Galah
Black Kite	Darter	Zebra Finch
Willy Wagtail	Great Egret	Cattle Egret
Whistling Kite	Mistletoebird	Black-faced Cuckoo-shrike
Diamond Dove	Yellow-tinted honeyeater	Red-backed Fairy-wren
Long-tailed Finch	Plumed Whistling Duck	Apostlebird
Royal Spoonbill	Crested Pigeon	Grey-crowned Babbler
Great Cormorant	Wedge-tailed Eagle	Common Bronzewing

3.4 Conclusion and recommendations

The desktop assessment provided broad-scale environmental descriptions and a detailed review of threatened species for the survey area. The next sections outline the recommendations made that should be addressed when considering the final project area of any exploration program.

3.4.1 Land condition

Weed invasion and spread is a key risk to biodiversity values and pastoral activities. Exploration activities can be a vector for the transport of weed material. A number of weeds are present within the region and the Katherine Region Weed Management Plan 2015-2020 identifies priority weeds.

3.4.2 Biodiversity values

The following biodiversity values were identified by desktop assessment and limited field survey.

Sensitive vegetation

The survey area supports one sensitive vegetation type – riparian vegetation. Riparian vegetation was observed within the survey area and is likely located at multiple locations along the two major watercourses. At the sites surveyed, riparian vegetation was limited to the immediate stream banks (i.e. it did not extend far from the watercourse). Given its confined extent, it is likely that riparian vegetation can be avoided by an exploratory drilling program.

Watercourses, wetlands and waterholes

The survey area supports some permanent freshwater waterholes. The waterholes (particularly Rocky Hole) support much higher biodiversity values than the surrounding area; they should be avoided by any drilling or seismic exploration program.

Threatened species

The survey area potentially supports populations or habitat for the following four threatened species (listed under the *TPWC Act* and/or the *EPBC Act)*

- Gouldian Finch
- Grey Falcon
- Crested Shrike-tit

- Mertens' Water Monitor

As two of these species (Grey Falcon and Crested Shrike-tit) have broad ranges and utilise woodland habitat that is common to the region, it is considered that an exploratory drilling or seismic exploration program is unlikely to have any significant impact on these species or their habitat.

The Gouldian Finch has more specific habitat requirements. There was potential habitat for the species found within the survey area. These areas were associated with hilled regions were there was *Eucalyptus leucophloia* present (nesting habitat).

Potential impacts to this species will be associated with clearing vegetation for drill pads, roads, and other related infrastructure; with the main direct impact being removal of current (or potential) nest sites. If the project avoids areas of Snappy Gum (*Eucalyptus leucophloia*), then there will not be a significant impact to the species. Even if areas of Snappy Gum need to be removed for project operations, it is unlikely that there will be a significant impact on the species; however, this should be confirmed prior to operations.

If more extensive works are proposed to be undertaken (for example a production operation), it is recommended that further work be undertaken to assess the risk and impact to Gouldian Finch. The steps involved in such work are outlined below:

- Phase 1: Conduct a habitat suitability assessment (desk-based assessment), which will include inspection if the proposed disturbance area falls within the land systems containing suitable habitat.
- Phase 2: If potential habitat is suspected to occur, follow up with on-ground studies to refine habitat features and update the 'likelihood of occurrence' assessment for the specific disturbance sites. For this species, the on-ground studies should also include a survey for evidence of Gouldian Finch (i.e. direct observation, potential nest sites, viable food resources, proximity to dry season water supply) and also characterisation of nesting habitat based on known hollow requirements. These surveys can be conducted at any time of year. Surveys should include a detailed habitat assessment of the site.
- Phase 3: If the habitat assessment indicates it is possible that Gouldian Finch inhabit the site, and if the habitat cannot be avoided from disturbance activities, more intensive survey methodology will be required to provide a more rigorous interrogation of the species' likelihood of occurrence. Standard survey techniques applicable for Gouldian Finch detection will be to undertake surveillance (i.e. stake-outs) on the suspected nest sites to determine if they are active, and if they belong to Gouldian Finch. Confirmed nest sites will be considered to be significant, and potential nest sites will also be considered to be significant if 'flyover' sightings are observed in the area. These surveys should occur in the late wet to mid dry season to ensure that breeding populations are encountered.

The abovementioned methods align with the *Survey Guidelines for Australia's Threatened Birds* (Commonwealth of Australia 2010).

Migratory species

Although there are three migratory species identified as having a medium likelihood of occurring within the survey area, it is not expected that an exploratory drilling program or seismic exploration program will have a significant impact on the species.

3.4.3 Recommendations

The biodiversity values mentioned in this document are either associated with habitat types that can be avoided (i.e. riparian vegetation) or that will not be significantly impacted through an exploratory drilling program or seismic exploration program (i.e. threatened species) due to the small area of disturbance.

Given the results of the biodiversity values assessment contained within this report, the following recommendations are made to minimise environmental impact:

- Ensure that the minimum setback distance as per the *Land Clearing Guidelines* are met to avoid impact to sensitive vegetation. These buffers should be measured from the boundary of the disturbance area to the edge of the riparian vegetation (rather than from the drill site/well head).
- Where possible, locate drill sites and seismic exploration activities within lateritic plains land systems, as field surveys and 'likelihood of occurrence' assessment indicated that these systems are the least likely to provide significant habitat for threatened species.
- Where possible, avoid impacts to Snappy Gums (*E. leucophloia)* (located primarily in the lateritic plateau land system but can occur on any rise); this will minimise any impact to Gouldian Finch.
- Prior to more-intensive works, further assessment of habitat for Gouldian Finch and potential impact to this species should be undertaken. This would include desktop assessment and on-ground studies, and assessed in relation to a project area (see Section 3.3.6).
- Prior to any works being undertaken ensure that appropriate weed management procedures are in place. All vehicles and equipment should be certified wee free prior to entry onto the property.
- Undertaking a weed survey at exploratory drilling sites and/or seismic exploration sites and along access tracks would provide baseline data. This would enable Santos to ensure that activities do not introduce or spread weeds.

4 FIELD ASSESSMENT

4.1 Purpose and scope

Santos has identified a project area for the 2019 exploration program (Section 2). Field assessments were undertaken in 2018 to address the recommendations of the desktop assessment. Particularly:

- Undertaking a weed survey at exploratory drilling and/or seismic exploration sites and along access tracks would provide baseline data. This would enable Santos to ensure that activities do not introduce or spread weeds.
- Prior to more intensive works being undertaken, it is recommended that further assessment of habitat for Gouldian Finch and potential impact to this species be undertaken. This would include desktop assessment and on-ground studies and would be assessed in relation to a project area
- As the identified exploration activities may intersect watercourses that may support sensitive vegetation in the form of riparian vegetation, Santos required the location of any sensitive vegetation to be identified so that potential impact to these communities could be avoided or minimised during exploration.

The project area is within the 2018 survey areas, as discussed in Section 2 and depicted in Figure 2-1.

4.2 Weed survey

4.2.1 Background

There are three classes of weeds declared under the NT *Weeds Management Act*, some of which are also considered Weeds of National Significance (WoNS). These weed classes, categorised based on the risk of impact and how difficult they are to control, are:

- Class A – to be eradicated
- Class B – growth and spread to be controlled
- Class C – not to be introduced into the NT (all Class A and B weeds are also Class C).

Weed surveys within EP 161 focused on the weed species already recorded on the property (see Table 4-1). Potential weeds of concern within the Katherine Region, outlined in the Katherine Regional Weed Management Plan 2015-2020 (DLRM 2015), were also considered (see Table 4-2).

Table 4-1. Declared weed species recorded within the EP

Common name	Scientific name	NT Class
Hyptis	*Hyptis suaveolens*	B/C
Rubber Bush[3]	*Calotropis procera*	B/C
Spinyhead sida	*Sida acuta*	B/C
Sicklepod	*Senna obtusifolia*	B/C

[3] Although Rubber Bush is only declared south of 16°30' S, it was included in this list as current exploration areas are just north of this latitude and EP161area crosses this line of declaration.

Table 4-2. Potential weeds within the project area

	Common name	Scientific name	NT Class	WoNS
Katherine region priority weeds	Mesquite*	*Prosopis spp.*	A/C	Y
	Prickly acacia*	*Vachellia nilotica*	A/C	Y
	Parkinsonia	*Parkinsonia aculeata*	B/C	Y
	Chinee Apple*	*Ziziphus mauritiana*	A/C	
	Mimosa*	*Mimosa pigra*	A/C	Y
	Bellyache Bush*	*Jatropha gossypiifolia*	A/C[4]	Y
	Gamba Grass*	*Andropogon gayanus*	A/C	Y
	Neem*	*Azadirachta indica*	B/C	
	Grader grass*	*Themeda quadrivalvis*	B/C	Y
	Snake weed	*Stachytarpheta spp.*	B/C	
	Devils Claw	*Martynia annua*	A/C	
Other declared weeds	Parthenium[5]	*Parthenium hysterophorus*	A/C	Y
	Starburr	*Acanthospermum hispidum*	B/C	
	Mossman River Grass	*Cenchrus echinatus*	B/C	
	Spiny-head Sida	*Sida acuta*	B/C	
	Flannel Weed	*Sida cordifolia*	B/C	
	Paddy`s Lucerne	*Sida rhombifolia*	B/C	
	Caltrop	*Tribulus terrestris*	B/C	
	Noogoora Burr	*Xanthium strumarium*	B/C	
	Khaki Weed	*Alternanthera pungens*	B/C	

* indicates weeds with an associated weed management plan

EcOz liaised with the Department of Environment and Natural Resources (DENR) Weeds Management Branch to confirm that the lists of species in Table 4-1 and Table 4-2 were comprehensive. The Weeds Management Branch agreed that the lists covered all weeds for which surveys should be conducted, whilst noting it was the wrong time of year (November) to survey for some weeds, e.g. Parthenium and Grader Grass.

The Weeds Management Branch were also consulted on the survey approach. The agreed approach was to walk all disturbance areas to search for weeds. The Weeds Management Branch also suggested surveying surrounding areas adjacent to the project area, i.e. infrastructure and access tracks, as any disturbance may provide opportunity for the establishment of weed seeds present within the soil.

[4] Bellyache bush classification depends on its location within the NT; the EP is within the Class A eradication zone.
[5] Parthenium, previously eradicated from the NT, has recently been recorded in the Katherine region.

4.2.2 Methods

Weed species were recorded according to data attributes outlined in the NT Weed Data Collection Manual (*Weed Management Branch NT 2015*) and included the following:

- Weed species name (using two letter initials)
- Patch size (m): 5, 20, 50, 100
- Density (%): 1 = absent
  2 = <1
  3 = 1 - 10
  4 = 11 - 50
  5 = >50
- Seed occurrence (seed dropped): S

4.2.3 Results

The baseline weed survey recorded 48 occurrences of a total of five declared weed species. The number of occurrences of each weed species is shown in Table 4-3, the location of weed records is shown in Figure 4-1. The majority of weeds occurred along station tracks.

Hyptis was the most abundant weed recorded, with 35 records, and had the broadest distribution. It was recorded primarily along access tracks and at watering points, with a few small patches of low density recorded within 5 km of Tanumbirini-2 well location and within the 500 m buffer.

One patch of Rubber Bush was found in paddocks adjacent to a station track Figure 4-1. The patch was relatively dense in a disturbed area, and appeared to extend into the paddock to the south west. Individuals in the patch were flowering and four plants were observed to have seed present. It is likely that seed is contained in the soil in the station track adjacent to the infestation. Although not declared at this location, it can cause significant environmental and financial damage. It is a declared weed south of the Carpentaria Highway – including in areas of EP161. The track adjacent to the infestation is not part of the project area, however, the infestation is noted here for benefit of planning future activities.

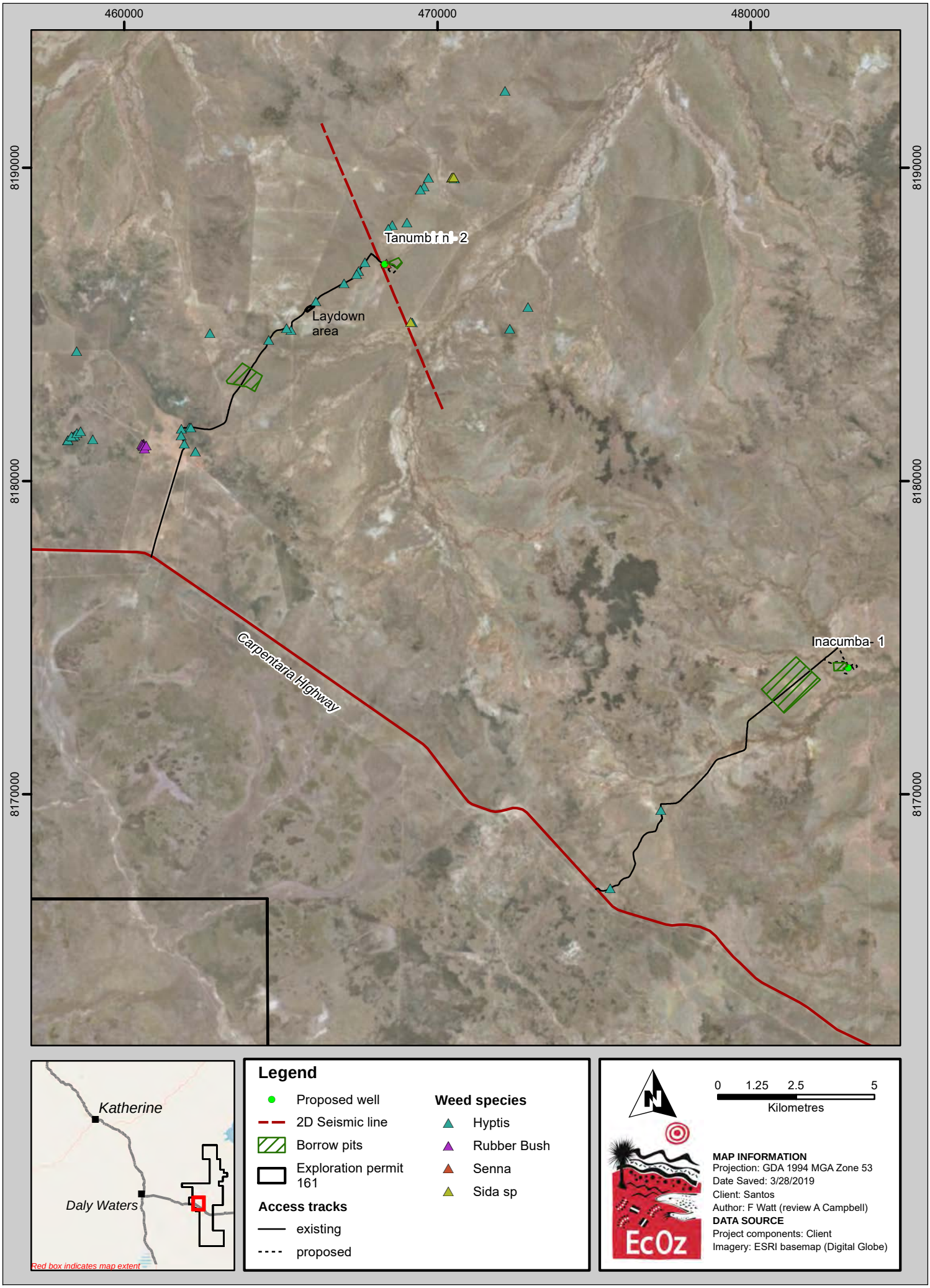
Surveyed patches of *Sida* sp. were only recorded at cattle watering points (Figure 4-1).

Table 4-3. Declared weed species with Tanumbirini-2 survey area

Common name	Scientific name	NT Class	No. of records	Seeded
Hyptis	*Hyptis suaveolens*	B and C	35	4 plants
Rubber Bush	*Calotropis procera*	B and C[6]	7	4 plants
Sida sp	*Sida* sp	B and C	4	None
Sicklepod	*Senna obtusifolia*	B and C	1	None

No weeds were observed within 500 m buffer of the Inacumba-1 well site. Two records of *Hyptis suaveolens,* were recorded along access track option 1 and 2. The location of recorded weeds is shown in Figure 4-1.

[6] South of 16°30'S



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19041 - Santos EP161 EMP aspects\01 Project Files\Figure 3-2. Location of weed occurrences within or adjacent to 2019 exploration program area.mxd

Figure 4-1. Weed occurrences within, or adjacent to, project area

4.3 Threatened species habitat

4.3.1 Background

The desktop assessment determined that Gouldian Finch (*Erythrura gouldiae*) had a medium chance of occurring with the survey area (which included the project area) (Section 3.2.5). Gouldian Finch is listed as endangered under both the *Environment Protection and Biodiversity Conservation Act* (*EPBC Act*) (1999) and the *Territory parks and Wildlife Conservation Act* (*TPWC Act*).

The critical components of suitable habitat for the Gouldian Finch vary seasonally. In the dry season, the critical components are hollow-bearing Eucalyptus trees (especially *E. tintinnans, E. brevifolia and E. leucophloia*) (Higgins et al. 2006; O'Malley 2006; Tidemann 1996; Tidemann et al. 1999) with an understorey of the favoured annual grass (*Sorghum* spp., *Schizachyrium* spp.) and a nearby (within 4 km) source of surface water. In the wet season, Gouldian finches rely on a variety of perennial grass species, and birds will move from area to area as the seeds from each species become available (Dostine and Franklin 2002; Dostine et al. 2001).

The breeding season extends from February to April, with a longer season (January to August) in years of extended wet season rainfall (Woinarski & Tidemann 1991; Tidemann & Woinarski 1994; Tidemann et al. 1999). Individuals or groups appear first to select patches of habitat with high densities of potential nesting sites, and breeding pairs then select specific nest sites based on a suite of preferred hollow morphometric attributes (Brazill-Boast et al. 2010).

The field inspections as part of the previous study (EcOz 2017) identified a number of sites where *E. leucophloia* was present on hilled areas within EP 161. The understorey species at these sites consisted of hummock, tussock or a mixture of hummock/tussock grass species. In a number of areas, the habitat was considered long unburnt (given the presence of large spinifex hummocks) and there were considerable hollows, which, through preliminary assessment, appeared to be suitable nesting locations.

4.3.2 Methods

Surveyors marked any occurrence of *E. leucophloia* within the project area. At each patch of *E. leucophloia* the following information was recorded:

- Tree density
- Tree heights (m)
- Type of trunk (single or ‘Mallee’)
- Hollow heights (m)
- Number of hollow > 25 mm
- General hollow angle
- Understorey vegetation description
- Fire impact

The habitat suitability of each patch of *E. leucophloia* for Gouldian Finch was categorised based on these characteristics.

4.3.3 Results

There are few patches of *E. leucophloia* within the project area. There is a small patch of *E. leucophloia* within the 500 m buffer of Tanumbirini-2. There are an additional nine patches of *E. leucophloia* within 5 km of Tanumbirini-2; the linear transects radiating out from Tanumbirini-2 crossed seven patches, and another two patches were observed opportunistically. The locations of *E. Leucophloia* patches detected during the survey, both within and outside the project area, are shown in Figure 4-2.

The access track to Tanumbirini-2 passed through a patch of *E. leucophloia*; however, this patch will not be disturbed by the project area. Similarly, the access track to Inacumba-1 passes by a patch of *E. leucophloia* that will not be disturbed by the project area.

There were no *E. leucophloia* trees within the 500 m buffer of the Inacumba-1 well site, nor will the use of the access track to Inacumba-1 result in the removal of any *E. leucophloia* trees.

The few patches of *E. leucophloia* represented typical open-woodland to woodland vegetation communities. The characteristics of six patches and the derived habitat suitability is shown in Table 4-4 (these patches were representative of the nine crossed by the linear transects). Although unconfirmed, it is likely that the patches are within 4 km of water given the number and location of stock watering points in addition to the small residual pools, which were present within the ephemeral drainages.

E. leucophloia trees within the survey area most commonly showed a 'mallee-like' growth form (i.e. many thin trunks emanating from a common base). The number of hollows per tree was between zero and five across all patches. However, the number of hollows greater than 25 mm was low in all but one patch (discussed below). In all cases, the *E. leucophloia* patches had a tussock grass understorey with minimal signs of recent fire impact.

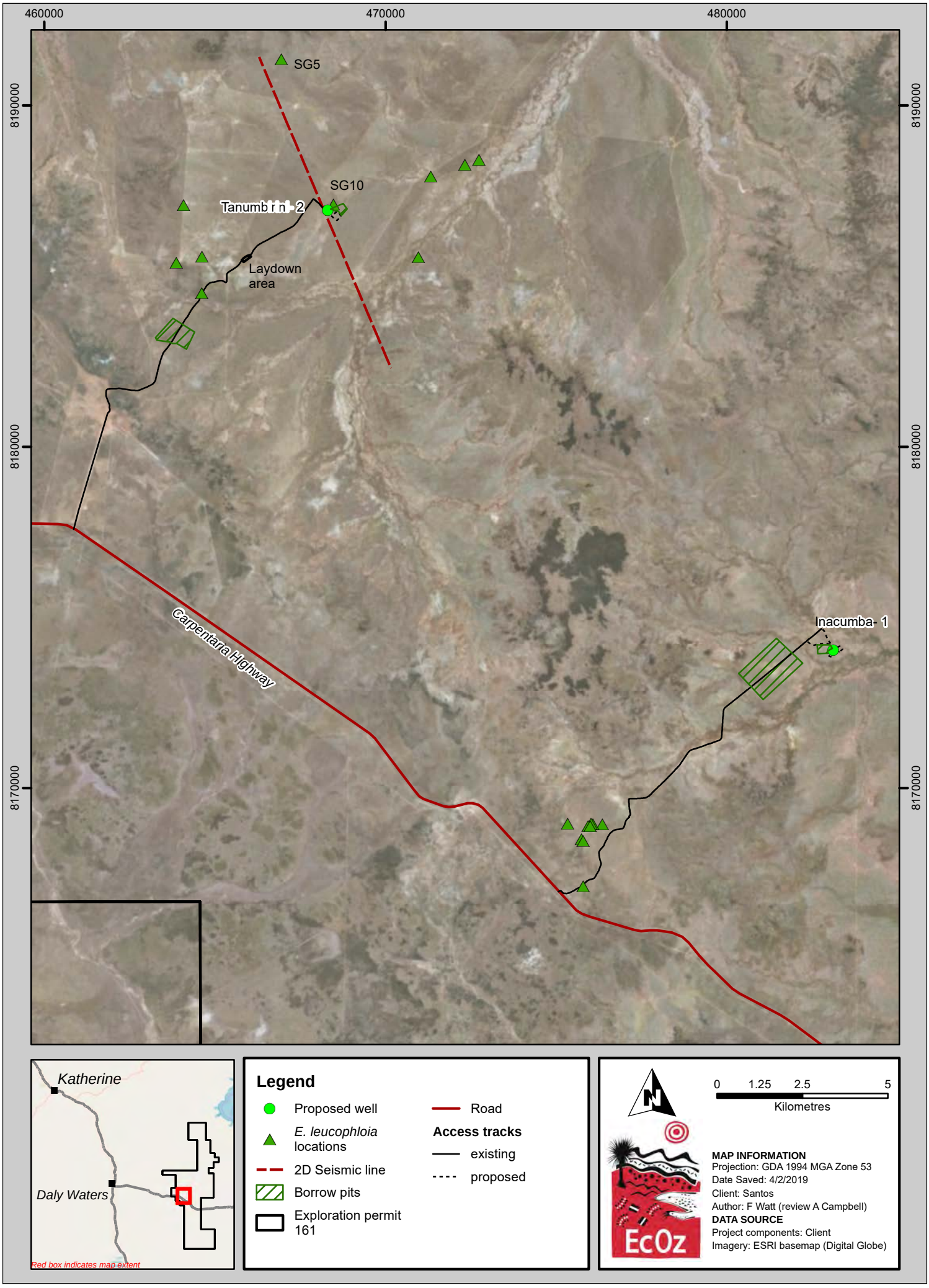
One patch (SG5) consisted of trees with single, larger trunks. Trees within this patch were relatively dense (40/ha) compared to other patches intersected. The number of hollows per tree were generally consistent with other patches; however, a larger percentage of hollows were greater than 25 mm wide.

No threatened species were observed during surveys. Long-tailed Finches were observed at a number of locations during the survey, and were consistently found at stock watering points. Anecdotal evidence suggests that Gouldian Finches do, or at least have occurred on Tanumbirini Station (and within EP161); however, they are more likely to occur in the northern sections – well outside the project area.

Habitat suitability assessment

The results of previous studies have shown that Gouldian Finches have strong preferences for specific hollow characteristics (Brazill-Boast 2010, Tidemann et al. 1992). Based on Brazill-Boast et al (2010), Gouldian Finches select hollows that are located in living tissue, are located in robust trees, are high off the ground, have smaller entrances, are deep into the trunk, and are close to horizontal. Studies investigating suitability of habitat for Gouldian Finch have found that density of hollows in preferred nesting habitat for the species is 4.6 hollows per hectare (Brazill-Boast et. al 2011) and 2 to 27 per hectare (Gibbons and Lindenmayer 2002).

Given these findings, although it is unknown whether these patches are used by nesting Gouldian Finches, three patches (SG8, SG9 and SG5) do present habitat that could be used by the species. Although there were hollows present, SG2 is not considered suitable habitat as only one hollow larger than 25 mm was found. Only two patches (SG5 and SG10) are intersected by the project area. SG5 is considered the best habitat for the species, as there were more hollows greater than 25 mm, tree density was high, the trees were single stemmed rather than mallee-like and the hollows were roughly horizontal. There are no hollows present within patch SG10, thus it is not considered suitable Gouldian Finch nesting habitat.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19041 - Santos EP161 EMP aspects\01 Project Files\Figure 4-1. Location of E leucophloia patches near 2019 exploration program area.mxd

Figure 4-2. Location of *E. leucophloia* patches near the project area

Table 4-4. Habitat characteristics of *E. leucophloia* patches within survey area.

Patch	Tree density (#/ha)	Tree heights (m)	Trunk type	Hollows per tree	Hollow heights (m)	Number hollows > 25 mm	General hollow angle	Vegetation	Fire impact	Suitability
SG8	4	8	Mallee	5	2 - 5	2*	45°	Open woodland of *Hakea sp* and *Acacia sp* over Tussock grassland	Nil	Moderate
SG9	7	8	Mixed	1 – 3	2 - 5	5*	90°	Sparse Acacia spp. shrubland over Tussock grassland	Nil	Moderate
SG2	10	6	Mallee	3	1 – 3	1*	40°	Sparse mid-story of *Hakea* spp. over Tussock grassland	-	Low
SG10	4	6	Mallee	0	N/A	N/A	N/A	*Themeda triandra* and *Heteropogon contortus*	Nil	Low
SG4	8	6 -7	Mixed	0	N/A	N/A	N/A	*Themeda triandra* and *Heteropogon contortus*	Nil	Low
SG5	40	6	Single	3 – 4	2.5 – 5	50% of hollows	90°	*Acacia* sp and *Grevillea* sp. over Tussock grassland, some *Themeda triandra*	Nil	High

** - total number of hollows (indicating percentage hollows > 25 mm is low)*

4.4 Riparian and sensitive vegetation

4.4.1 Background

Significant or sensitive vegetation communities are described in the *NT Land Clearing Guidelines* (NRETAS 2010). They are vegetation communities that are distinct and limited in extent or support important ecological values, and include rainforest, vine thicket, closed forest or riparian vegetation, mangroves, monsoon vines forest, sand-sheet heath and vegetation containing large trees with hollows suitable for fauna.

Within the project area, riparian vegetation is the most likely sensitive vegetation community to occur. Where it comprises sensitive vegetation, riparian vegetation is a distinct, closed forest community that creates suitable conditions for a range of species (terrestrial and aquatic) by providing shade (DLRM 2013). It covers a relatively small land area, provides unique habitat features and dry season refuge for a range of native fauna species, and is important for maintaining bank stability and reducing erosion (DLRM 2013).

Initial site visits determined that such closed forest community riparian vegetation was present within the survey area (Figure 4-3 left). Analysis of aerial imagery indicates the project area crosses ephemeral watercourses; however, not all the vegetation along these watercourses should be considered a sensitive riparian community. The majority of vegetation along the ephemeral watercourses in the area is an extension of the surrounding vegetation communities, or consists of species not found in the surrounding vegetation (e.g. *Eucalyptus camaldulensis*) but is sparse and does not provide the habitat characteristics or bank stabilising properties of sensitive riparian vegetation communities (Figure 4-3 right).

In this report, two terms are used to describe vegetation along a watercourse:

- Riparian vegetation – vegetation considered sensitive under the *NT Land Clearing Guidelines* (e.g. Figure 4-3 left).
- Drainage line vegetation – vegetation along a drainage line but not considered sensitive riparian vegetation under the *NT Land Clearing Guidelines* (e.g. Figure 4-3 right).

Figure 4-3. Examples of sensitive riparian vegetation (left) and drainage line vegetation (right).

Field surveys were undertaken to determine where the project area intersected riparian vegetation and drainage line vegetation.

4.4.2 Methods

Surveyors recorded the location of riparian and drainage line vegetation on a handheld GPS when encountered along the survey transect, and the dominant upper strata species of the vegetation. Photographs were taken to confirm the presence of drainage channels and any vegetation present along the drainage channel.

Waypoints were loaded into an ArcGIS project to indicate the location of riparian and drainage line vegetation on aerial imagery (ESRI Base maps). Inside the 500 m well buffers, aerial imagery at a 1:10,000 scale was used to differentiate riparian and drainage line vegetation from surrounding vegetation types. Polygons were drawn to delineate patch boundaries; polygons were created for both riparian vegetation and drainage line vegetation.

4.4.3 Results

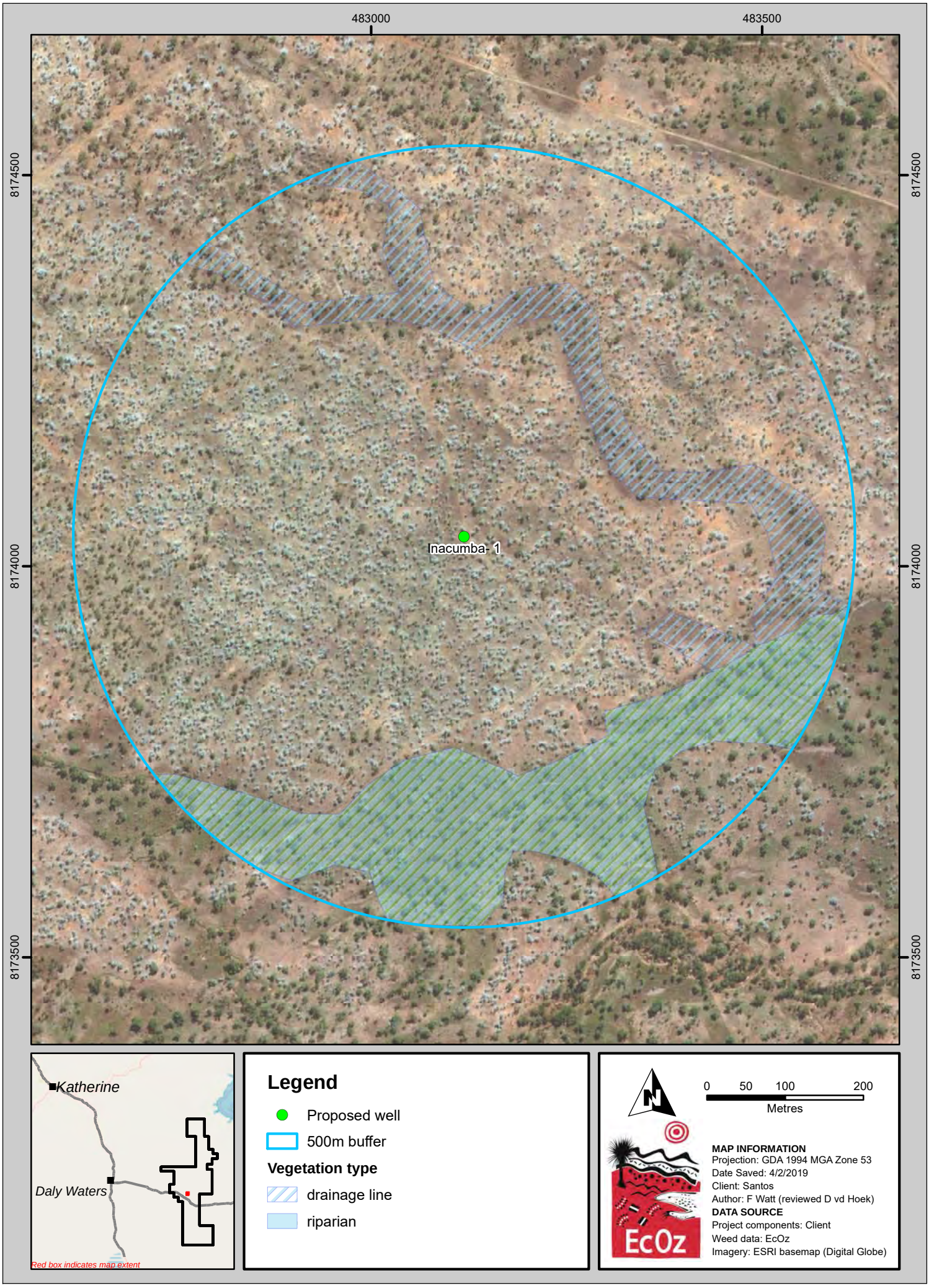
There is a patch of riparian vegetation along the edge of drainage channels within the southern sections of the Inacumba-1 survey area. *Eucalyptus camaldulensis* and *Terminalia bursarina* are the dominant species in this open woodland community. This vegetation is associated with Inacumba Creek, a minor watercourse of stream order three. There is also a patch of drainage line vegetation extending from the north of the survey to the south east. This vegetation community consists of *Eucalyptus camaldulensis* and *Terminalia bursarina*, as well as *Eucalyptus pruinosa*, a species that dominates the surrounding open woodland within the Inacumba-1 survey area.

The location of riparian and drainage areas has been mapped for the Inacumba-1 survey area and is shown in Figure 4-5. Photos of riparian and drainage line vegetation within Inacumba-1 are shown in Figure 4-4.

Figure 4-4. Photos of riparian (left) and drainage line (right) vegetation within Inacumba-1 survey area

The vegetation intersected by linear transects radiating out from Tanumbirini-2 at watercourse crossings comprised primarily a narrow strip of *Eucalyptus camaldulensis* in the upper-storey. Canopy cover along this strip is higher than the surrounding woodland and open plains; however, visual inspection did not indicate that canopy foliage cover was sufficiently dense for the vegetation to be classified as a forest community.

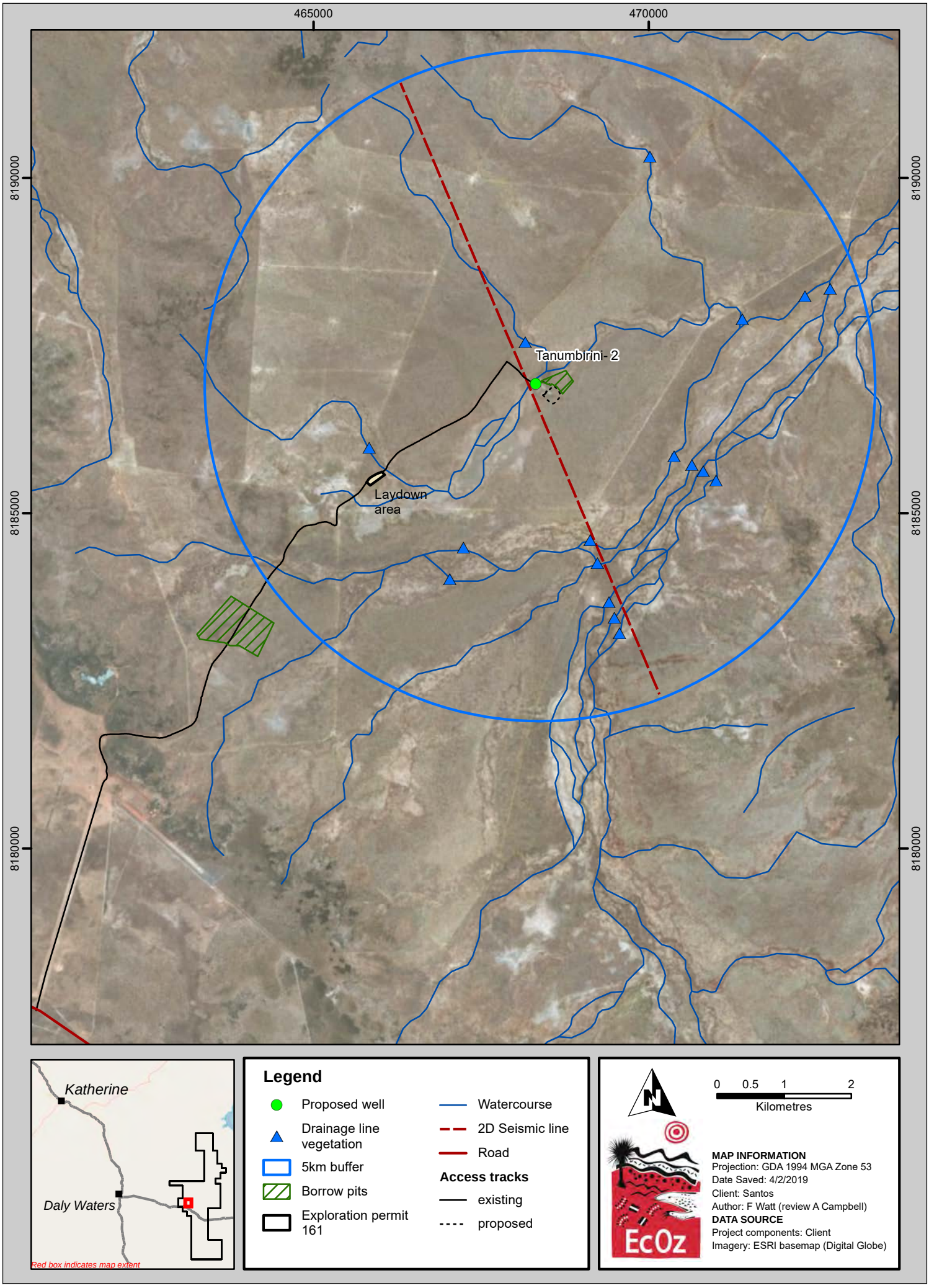
Height of upper-storey of riparian vegetation was between 5 and 10 metres. There was limited mid-storey vegetation at any of the watercourse crossing sites. Ground cover comprised tussock grasses consistent with the surrounding vegetation community. Vegetation at a number of drainage lines did not show any distinction between that of the surrounding landscape. Photos of vegetation at locations watercourses are shown in Figure 4-6.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19041 - Santos EP161 EMP aspects\01 Project Files\Figure 5-2. Location of riparian and drainage line vegetation within Inacumba 1_1H survey area.mxd

Figure 4-5. Map showing location of riparian and drainage line vegetation within Inacumba-1 survey area

Figure 4-6. Photos of drainage line vegetation along transects radiating from Tanumbirini-2



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19041 - Santos EP161 EMP aspects\01 Project Files\Figure 5-5. Map showing locations of drainage line vegetation along transects from Tanumbirini- 2.mxd

Figure 4-7. Map showing locations of drainage line vegetation along transects from Tanumbirini- 2

4.5 Discussion

Surveys within the project area were completed targeting:

- Listed weed species
- Threatened species habitat and incidental species observations
- Sensitive vegetation

Weed diversity within the project area is low, with only five weed species recorded. Weeds are also at low densities except for Hyptis, which also occurs outside the project area and is common throughout the region. There is one patch of Rubber Bush beside an access track; however, this track is not part of the project area. The majority of weeds were recorded along access tracks or at stock watering points. Although it is likely that there is Hyptis seed within the station access tracks, the species is currently wide spread along the access tracks likely to be used in exploration activities.

The project area intersects two patches of *E. leucophloia*. The *E. leucophloia* patches, although relatively small should be considered as potential Gouldian Finch habitat. Although the density of trees with SG5 is relatively high, densities of *E. leucophloia* is such that seismic activities should be able to avoid impacting trees. In the event that a tree does need to be removed for seismic activities, it is likely that only a small number of trees will be affected. Best practice environmental management of minimising the disturbance to the smallest extent required should be employed as routine; however, it is not considered that specific management controls be undertaken.

The vegetation along the watercourses crossed by the 2D seismic line, although denser than surrounding communities, is not considered to be a riparian forest community and, as such, not sensitive vegetation. The vegetation is also sparse enough that the vehicles involved in 2D seismic exploration should be able to avoid impact to vegetation along drainage lines. Minimising the disturbance to vegetation along the drainage lines will help maintain stability of the watercourses, reduce sedimentation and retain wildlife habitat.

Patches of riparian vegetation were recorded within the southern section of Inacumba-1. Clearing within these areas should be avoid if possible to minimise the risk of erosion and sediment transfer within these areas during periods of concentrated overland flow. The appropriate buffers, as detailed in the *NT Land Clearing Guidelines*, should be applied.

EcOz makes the following recommendations for the 2019 exploration activities:

Weeds

- All vehicles involved in exploration activities should be certified weed free prior to entering Tanumbirini Station.
- Weeds should be surveyed and controlled according to the requirements outlined within the Santos – Weed Management Plan – EP 161 (EcOz, 2019)

Gouldian Finch

- Avoid removal of *E. leucophloia* trees within the patches along the 2D seismic line. This should be achievable through the design of the seismic survey (i.e. vehicles weave through trees) without specific management controls. If significant numbers of trees are to be removed, consideration should be given to having environmental staff on site to identify ways to minimise impact to *E. leucophloia*.
- Although considered unlikely, if Gouldian Finches are observed incidentally during further environmental assessments (such as post Wet Season weed assessment) or project activities, Santos will engage experienced ecologists to complete further assessment. This may include population characterisation or further habitat assessment.

Sensitive vegetation

- Clearing within areas mapped as riparian vegetation within Inacumba-1 buffer should be avoided where possible.

Borrow pits

- Prior to disturbance of areas for the extraction of borrow material, environmental staff (either from Santos or a consultant) should ensure that there are no significant environmental values in the final areas selected.

Although there is not expected to be any impact to Mertens' Water Monitor, if the species are observed incidentally during further environmental assessments (such as post Wet Season weed assessment) or project activities, Santos will engage experienced ecologists to complete further assessment.

5 REFERENCES

Baker, B, Price, O, and Woinarski, J, (2005), *Northern Territory Bioregions – assessment of key biodiversity values and threats*, Biodiversity Group, Biodiversity Conservation, Department of Natural Resources Environment and the Arts, Darwin, Northern Territory.

Brazill-Boast J, Pryke SR and Griffith SC, 2010, 'Nest-site utilisation and niche overlap in two sympatric, cavity-nesting finches', *Emu*, 110, pp. 170-177.

Brazill-Boast J & Pryke SR, 2011, 'Breeding habitat selection in the endangered Gouldian Finch (*Erythrura gouldiae*) at two spatial scales', *Emu*, 111(4) 304-31.

Christian, K. (2004). Varanus mertensi. In: Pianka et al. (eds.). *Varanoid lizards of the world*. Indiana University Press, Bloomington, Indianapolis.

Department of Natural Resources, Environment, The Arts and Sport (NRETAS), 2010, Land clearing guidelines, Department of Natural Resources, Environment, The Arts and Sport, Darwin. Northern Territory, viewed online 01 September 2018, https://nt.gov.au/__data/assets/pdf_file/0007/236815/land-clearing-guidelines.pdf

Dostine PL and Franklin DC, 2002, A comparison of the diet of three finch species in the Yinberrie Hills area, Northern Territory. *Emu,* 102, 159-164.

Dostine PL, Johnson GC, Franklin DC, Zhang Y and Hempel C, 2001, Seasonal use of savanna landscapes by the Gouldian finch, *Erythrura gouldiae*, in the Yinberrie Hills area, Northern Territory, *Wildlife Research* 28, 445-458.

EcOz 2018a, Ecology report – EP161 work program 2018, prepared for Santos.

EcOz 2018b, Inacumba bore weed survey and sensitive vegetation assessment, prepared for Santos.

EcOz 2019, Weed management plan EP161, prepared for Santos

Gibbons, P & Lindenmayer, D (2002), *Tree Hollows and Wildlife Conservation in Australia*, CSIRO publishing, Collingwood, Victoria.

Higgins PJ, Peter JM and Cowling SJ (eds), 2006, 'Boatbill to Starlings', In: *Handbook of Australian, New Zealand and Antarctic Birds Volume 7*, Oxford University Press, Melbourne, Victoria.

O'Malley C, 2006, '*National Recovery Plan for the Gouldian Finch (Erythrura gouldiae)*', WWF Australia, Sydney and Parks and Wildlife Northern Territory, Department of Natural Resources, Environment and the Arts, Northern Territory Government, Palmerston.

Tidemann SC, 1996, Causes of the decline of the Gouldian Finch (Erythrura gouldiae), *Biological Conservation International*, 6, pp. 49—61.

Tidemann SC, Lawson C, Elvish R, Boyden J & Elvish J, 1999, 'Breeding biology of the gouldian finch Erythrura gouldiae, an endangered finch of northern Australia', *Emu,* 99, pp. 191-199.

Tidemann SC, and Woinarski JCZ, 1994, 'Moult characteristics and breeding seasons of Gouldian Erythrura gouldiae, Masked Poephila personata and Long-tailed Finches P. acuticauda in savannah woodland in the Northern Territory', *Emu*, 94: pp. 46—52

Ward, S., Woinarski, J., Griffiths, T. and McKay, L. (2006). *Threatened Species of the Northern Territory - Mertens Water Monitor - Varanus mertensi*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0018/206460/mertens-water-monitor.pdf [Accessed 1 May 2018].

Woinarski JCZ, and Tidemann SC, 1991, 'The bird fauna of a deciduous woodland in the wet-dry

tropics of northern Australia', *Wildlife Research*, 18: pp. 479-500.

APPENDIX A PROTECTED MATTERS SEARCH TOOL REPORT

APPENDIX B LIKELIHOOD OF OCCURRENCE ASSESSMENT FOR THREATENED SPECIES WITHIN SURVEY AREA

Name	Status		Summary	Likelihood of occurrence
	Cth	NT		
BIRDS				
Carpentarian Grasswren *Amytornis dorotheae*	EN	EN	**Habitat:** NT population is restricted to dissected, topographically complex, sandstone and conglomerate hills and plateaux with infrequent fires (Lewis & Woinarski 2006). The only recent observations were recorded in a site that had been burnt only twice in the preceding 12 years. All other historic sites with no recent observations had been burnt between three and eight times. **Distribution:** Gulf of Carpentaria hinterland – between Limmen River in the NT and Mount Isa in Qld. No records in the Borroloola area since 1986 despite several targeted surveys in the last decade (Martin & McKean 1986; Garnett et al. 2011). Within the NT, now restricted to a tiny isolated population approximately 6 km to the west of Calvert Hills Station in the Wollogorang area (TSSC 2016).	**NONE** • Only a small area of rocky quartz sandstone outcropping (recently burnt) within the survey area which is unlikely to provide suitable habitat. • This species has a very restricted range that is not proximate to the survey area. • Closest known occurrence is approx. 100km ENE and pre-2000.
	Garnett, S.T., Szabo, J.K. and Dutson, G. (2011). *The Action Plan for Australian Birds 2010*. CSIRO Publishing. Collingwood, Australia. Lewis, M. & Woinarski, J. (2006). *Threatened Species of the Northern Territory - Carpentarian Grass-wren - Amytornis dorotheae.* Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0007/373543/carpentarian-grasswren.pdf [Accessed 18 April 2017]. Martin, K.C. & McKean, J.L. (1986). *A study of the distribution and status of the endangered Carpentarian grasswren Amytornis dorotheae.* Report to the Conservation Commission of the Northern Territory, Palmerston, NT. Threatened Species Scientific Committee (2016). *Conservation Advice – Amytornis dorotheae – Carpentarian Grasswren.* Canberra: Department of the Environment. In effect under the EPBC Act from 05-May-2016. [online] Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/558-conservation-advice-05052016.pdf [Accessed 18 April 2017].			
Red Goshawk *Erythrotriorchis radiates*	VU	VU	**Habitat:** Prefers tall, open *Eucalyptus* forest and riparian areas. Nests in large trees, frequently the tallest and most massive in a tall stand, nest trees are invariably within 1 km of permanent water (Debus & Czechura 1988; Aumann & Baker-Gabb 1991). **Distribution:** Sparsely distributed across much of the northern Australia, from the Kimberley in WA to south-eastern Qld. Within this range, generally occurs in taller forests characteristic of higher rainfall areas, but there are some isolated records from central Australia (Woinarski 2006).	**LOW** • No tall open *Eucalyptus* forest within 1 km of permanent water observed within the survey area. • This is the southern extent of core range. • There is little riparian habitat within survey area. • Closest known occurrence is approx. 150km NW in 2010.
	Aumann, T. & Baker-Gabb, D. (1991). *A Management Plan for the Red Goshawk*. RAOU Report 75, Royal Australasian Ornithologists Union, Melbourne. Debus, S. & Czechura, G. (1988). Field identification of the Red Goshawk Erythrotriorchis radiates. *Australian Bird Watcher*, Vol. 12, pp. 154-159. Woinarski, J. (2006). *Threatened Species of the Northern Territory - Red Goshawk - Erythrotriorchis radiates*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0018/206352/red-goshawk.pdf [Accessed 18 April 2017].			
Gouldian Finch			**Habitat:** Prefers annual and perennial grasses (especially *Sorghum*), a	**MEDIUM**

Erythrura gouldiae	EN	VU	nearby source of surface water and – in the breeding season – unburnt, hollow-bearing Eucalyptus trees (especially *E. tintinnans, E. brevifolia* and *E. leucophloia*) (Tidemann 1996; O'Malley 2006). **Distribution:** Sparsely across northern Australia from the Kimberley to north-central Qld (Dostine 1998; Franklin et al. 1999; Barrett et al. 2003; Franklin et al. 2005). In the NT, most known breeding populations occur in the Top End. Non-breeding birds disperse widely (Garnett et al. 2011), greatly increasing the possible range of this species.	• *Eucalyptus leucophloia* woodlands provide suitable breeding habitat within the survey area. • The survey area is towards the edge of the known range of this species. • Two closest known occurrences are within 30km of the survey area, in 2009 and 1962.
	Barrett, G., Silcocks, A., Barry, S., Cunningham, R. & Poulter, R. (2003). *The New Atlas of Australian Birds*. Royal Australian Ornithologists Union, Melbourne, Victoria. Dostine, P. (1998). *Gouldian Finch Recovery Plan Erythrura gouldiae*. Gouldian Finch Recovery Team and Parks & Wildlife Commission NT, Darwin. Franklin, D.C., Burbidge, A.H. & Dostine, P.L. (1999). The harvest of wild birds for aviculture: an historical perspective on finch trapping in the Kimberley with special emphasis on the Gouldian Finch. *Australian Zoologist,* Vol. 31, pp. 92-109. Franklin, D.C., Whitehead, P.J., Pardon, G., Matthews, J., McMahon, P. & McIntyre, D. (2005). Geographic patterns and correlates of the decline of granivorous birds in northern Australia. *Wildlife Research*, Vol. 32, pp. 399-408. Garnett, S.T., Szabo, J.K. and Dutson, G. (2011). *The Action Plan for Australian Birds 2010*. CSIRO Publishing. Collingwood, Australia. O'Malley, C. (2006). *National Recovery Plan for the Gouldian Finch (Erythrura gouldiae*). WWF-Australia, Sydney and Parks and Wildlife NT, Department of Natural Resources, Environment and the Arts, NT Government, Palmerston. Tidemann, S.C. (1996). Causes of the decline of the Gouldian Finch *Erythrura gouldiae*. *Biological Conservation International*, Vol. 6, pp. 49-61.			
Grey Falcon *Falco hypoleucos*	-	VU	**Habitat:** Occurs in areas of lightly-timbered lowland plains, typically on inland drainage systems, where the average annual rainfall is less than 500 mm (Ward 2012). **Distribution:** Sparsely distributed through much of the arid and semi-arid areas of Australia but is recorded in all Australian mainland states and territories. In the NT, the majority of records are from the southern half, but there are records all the way up to Darwin (Ward 2012).	**MEDIUM** • Region experiences higher rainfall than 500 mm annually. • Open woodland vegetation within the survey area may provide suitable habitat. • The species has a broad range but is naturally rare. • Closest known occurrence was 100km NW in 2000.
	Ward, S. (2012). *Threatened Species of the Northern Territory - Grey Falcon - Falco hypoleucos*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0020/206354/grey-falcon.pdf [Accessed 23 March 2017].			
Crested Shrike-tit (northern subspecies) *Falcunculus frontatus whitei*	VU	-	**Habitat:** Recorded in eight different woodland types in northern Australia, mainly those dominated by *Eucalyptus miniata, E. tetrodonta* or *E. bleeseri* (Robinson & Woinarski 1992). **Distribution:** North-western Australia from the Kimberley in WA, across the Top End of the NT to Borroloola (TSSC 2016). In the NT, recorded in very low densities in many isolated subpopulations (Garnett & Crowley 2000) between north-east Arnhem land and semi-arid Victoria River District. Scarcity of records suggests that populations are at very low density (Woinarski 2004). Not known to have disappeared from any area where recorded historically (TSSC 2016).	**MEDIUM** • Woodland vegetation within the survey area is potential habitat for the species. • Known occurrences are more than 150km from the survey area. • Although suitable habitat exists within the survey area, they are naturally rare.
	Garnett, S.T. & Crowley, G.M. (2000). *The Action Plan for Australian Birds 2000*. Environment Australia and Birds Australia, Canberra, ACT. Robinson, D. and Woinarski, J.C.Z. (1992). 'A review of records of the Northern Shrike-tit *Falcunculus frontatus whitei* in north-western Australia'. *South Australian Ornithologist*, Vol. 31, pp. 111-117. Threatened Species Scientific Committee (2016). *Approved Conservation Advice for Falcunculus frontatus whitei - crested shrike-tit (northern)*. Canberra: Department of the Environment. In effect under the			

	EPBC Act from 02-May-2016. Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/26013-conservation-advice-05052016.pdf [Accessed 18 April 2017]. Woinarski, J.C.Z. (2004). *National multi-species Recovery Plan for the Partridge Pigeon [eastern subspecies] Geophaps smithii smithii; crested shrike-tit [northern (sub)-species] Falcunculus (frontatus) whitei; masked owl [north Australian mainland subspecies] Tyto novaehollandiae kimberli; and masked owl [Tiwi Islands subspecies] Tyto novaehollandiae melvillensis, 2004-2008*. NT Department of Infrastructure Planning and Environment, Darwin.			
Partridge Pigeon (eastern subspecies) *Geophaps smithii smithii*	VU	VU	**Habitat:** Occurs in open forests and woodlands with an understorey of grasses (Woinarski 2006). Prefers woodland dominated by *Eucalyptus tetrodonta* and *Eucalyptus miniata* (Braithwaite 1985; Garnett et al. 2011; Higgins & Davies 1996). **Distribution:** Historically, across the Top End (from Kununurra in WA to Borroloola in the NT). Since early 20th century a severe range contraction from the western, eastern and southern parts of the former distribution (Higgins & Davies 1996; Woinarski et al. 2007). Currently, distribution is limited to sub-coastal NT from Yinberrie Hill in the south, Litchfield NP in the west and (western) Arnhem Land in the east (Garnett et al. 2011).	**LOW** • Preferred *E. tetrodonta* and *E. miniata* dominated woodland is not present within survey area. • The survey area is at the edge of the known range. • Closest known occurrences are more than 100km E. • This species has likely experienced a significant range contraction.
	Braithwaite, R.W. (1985). *The Kakadu fauna survey: an ecological survey of Kakadu National Park*. Australian National Parks & Wildlife Service, Canberra. Garnett, S.T., Szabo, J.K. and Dutson, G. (2011). *The Action Plan for Australian Birds 2010*. Birds Australia, CSIRO Publishing, Melbourne. Higgins, P.J. and Davies S.J.J.F. (eds) (1996). *Handbook of Australian, New Zealand and Antarctic Birds. Volume Three: Snipe to Pigeons*. Oxford University Press. Melbourne, Victoria. Woinarski, J.C.Z. (2006). *Threatened Species of the Northern Territory - Partridge Pigeon (eastern subspecies) - Geophaps smithii*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0003/206355/partridge-pigeon.pdf [Accessed 18 April 2017]. Woinarski, J., Pavey, C., Kerrigan, R., Cowie, I. and Ward, S. (Eds) (2007). *Lost from Our Landscape: Threatened Species of the Northern Territory*. Northern Territory Government, Darwin.			
Painted Honeyeater *Grantiella picta*	VU	VU	**Habitat:** Acacia and Eucalyptus-dominated woodlands and open forest, preferring habitats with more mature trees that host more mistletoe. Breeding times and seasonal movements (south to north) likely governed by the fruiting of mistletoe (Garnett et al. 2011). **Distribution:** Across eastern and northern parts of the country – but nowhere very numerous (Ward 2012). Many birds move after breeding to semi-arid regions such as north-eastern SA, central and western Qld, and central NT (TSSC 2015). Few NT records – most from the Barkly Tablelands – but no evidence of a breeding population in the NT, and the records are likely irregular visitors from south-eastern Australia (Ward 2012).	**LOW** • Acacia and Eucalyptus woodlands within the survey area may provide suitable habitat. • While there are two more recent occurrences (2001 & 2005) located ~100km NE and SW of survey area, it is considered an irregular visitor to the NT.
	Garnett, S.T., Szabo, J.K. and Dutson, G. (2011). *The Action Plan for Australian Birds 2010*. CSIRO Publishing, Collingwood, Australia. Threatened Species Scientific Committee (TSSC) (2015). *Approved Conservation Advice for Grantiella picta (Painted Honeyeater)*. Canberra: Department of the Environment. Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/470-conservation-advice.pdf [Accessed 7 April 2017]. Ward, S. (2012). *Threatened Species of the Northern Territory – Painted Honeyeater - Grantiella picta.* Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0009/373554/painted-honeyeater.pdf [Accessed 7 April 2017].			
Masked Owl (northern subspecies) *Tyto novaehollandiae kimberli*	VU	VU	**Habitat:** Mainly in *Eucalyptus* tall open forests (especially those dominated by *Eucalyptus miniata* and *E. tetrodonta*), but also roosts in monsoon rainforests and forages in more open vegetation types, including grasslands (Woinarski & Ward 2012). **Distribution:** Poorly known, with few records from across a broad range in northern Australia. In the NT, records from the Top End, Kakadu, Coburg Peninsula (majority of records) and south-west Gulf country (Woinarski &	**LOW** • No suitable tall open Eucalyptus forest for roosting habitat is present in the survey area. Open woodland habitat may provide suitable foraging habitat. • Naturally rare, one known occurrence >100km E of survey area in 1977.

			Ward 2012).	• Survey area is located at the edge of known range.
	Woinarski, J.C.Z. and Ward, S. (2012). *Threatened Species of the Northern Territory - Masked Owl (north Australian mainland subspecies) - Tyto novaehollandiae kimberli.* Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/word_doc/0008/373553/masked-owl-mainland-top-end.docx [Accessed 7 April 2017].			
Eastern Curlew **Greater Sand Plover** **Curlew Sandpiper**	-	VU	**Habitat:** Coastal and estuarine with tidal mudflats. May roost during high tide on nearby beaches. May also be found at near-coastal swamps and lakes (apart from Red and Great Knot) **Distribution:** Mostly widespread around the northern Australian coast, less common in the south, with few inland records. Eastern Curlew is uncommon across Australia while Asian Dowitcher is rare. Every year these species breed in the northern hemisphere in the summer, and migrate to Australia for the southern hemisphere summer. Some birds remain in Australia during the winter. [Information above summarised from Chatto (2003), DoE (2015) and Garnett et al. (2011)].	**NONE** • There are no tidal mudflats, preferred by these species, within the survey area.
	Chatto, R. (2003). *The distribution and status of shorebirds around the coast and coastal wetlands of the Northern Territory*. Technical Report 73, Parks and Wildlife Commission of the Northern Territory, Darwin. [online] Available at: https://dtc.nt.gov.au/__data/assets/pdf_file/0008/279917/2003_shorebirds_rpt76.pdf [Accessed 19 April 2017]. Department of the Environment (2015). *EPBC Act Policy Statement 3.21 - Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species.* Commonwealth of Australia, Canberra, ACT. [online] Available at: http://www.environment.gov.au/epbc/publications/shorebirds-guidelines [Accessed 19 April 2017]. Garnett, S.T., Szabo, J.K. and Dutson, G. (2011). *The Action Plan for Australian Birds 2010*. CSIRO Publishing. Collingwood, Australia.			
Australian Painted Snipe *Rostratula (benghalensis) australis*	EN	VU	**Habitat:** Fringes of permanent and temporary wetlands, swamps and inundated grasslands (Taylor et al. 2013). **Distribution:** Nomadic and scattered across Australia with no predictable occurrence (Rogers 2001), but could occur at any wetland or inundated grassland across its distribution, including nearly all of the NT and Qld (Garnett et al. 2011).	**LOW** • Closest known occurrence is approx. 50km NE (record from 1985), others are >100km away. • Nomadic species. • Inundation of grassland may provide seasonally suitable (but not core) habitat.
	Garnett, S.T., Szabo, J.K. and Dutson, G. (2011). *The Action Plan for Australian Birds 2010*. CSIRO Publishing. Collingwood, Australia. Rogers, D. (2001). Painted Snipe. *Wingspan*, Vol. 11 (No. 4), pp. 6-7. Taylor, R., Chatto, R. and Woinarski, J.C.Z. (2013). *Threatened Species of the Northern Territory - Australian pained snipe - Rostratula australis*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0018/206361/australian-painted-snipe.pdf [Accessed 23 March 2017].			
MAMMALS (TERRESTRIAL)				
Brush-tailed Rabbit-Rat *Conilurus penicillatus*	VU	EN	**Habitat:** Largely restricted to mixed *Eucalyptus* open forest and woodland, or on dunes with *Casuarina* – seeming to prefer habitats that are not burnt annually, that have an understorey of predominantly perennial grasses and a sparse-to-moderate middle storey (Firth et al. 2006; Firth 2007; Kemper & Firth 2008). **Distribution:** Formerly widespread across northern Australia, but has declined extensively from Qld and lower rainfall areas of the Kimberley in WA and the Top End in the NT. No recent records from much of the historically-recorded NT range between near the mouth of Victoria River (in the west) and Sir Edward Pellew island group (in east). Most recently known from	**LOW** • There are no known occurrences nearby, with the closest more than >150km N (2 specimens) – date not specified. • This species has likely experienced a significant range contraction and they may now be locally extinct .

			Cobourg Peninsula, Tiwi Islands, Groote Eylandt and a small area within Kakadu National Park (Woinarski & Hill 2012).	
	Firth, R.S.C. (2007). *Ecology and conservation status of the brush-tailed rabbit-rat Conilurus penicillatus*. PhD thesis, Charles Darwin University, Darwin, Northern Territory. Firth, R.S.C., Woinarski, J.C.Z. and Noske, R.A. (2006). Home range and den characteristics of the brush-tailed rabbit-rat *Conilurus penicillatus* in the monsoonal tropics of the Northern Territory, Australia. *Wildlife Research*, Vol. 33, pp. 397-408. Kemper, C.M. and Firth, R.S.C. (2008). Brush-tailed Rabbit-rat. In: Van Dyck, S. and Strahan, R. (eds). *The Mammals of Australia*. Reed New Holland, Chatswood, NSW. Woinarski, J.C.Z. and Hill, B. (2012). *Threatened Species of the Northern Territory - Brush-tailed rabbit-rat, Brush-tailed tree-rat - Conilurus penicillatus*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0016/205504/brush-tailed-rabbit-rat.pdf [Accessed 20 April 2017].			
Western Quoll *Dasyurus geoffroii*	VU	EX	**Habitat:** In central Australia, occurred throughout a range of habitats (Pavey 2006). **Distribution:** Historically occurred throughout the arid interior of the NT, now restricted to the south-west of WA (Pavey 2006). Considered extinct in the NT since the 1960's.	**NONE** • Locally extinct.
	Pavey, C. (2006). *Threatened Species of the Northern Territory - Western Quoll, Chuditch - Dasyurus geoffroii*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0018/205470/western-quoll.pdf [Accessed 23 March 2017].			
Northern Quoll *Dasyurus hallucatus*	EN	CR	**Habitat:** Wide range of habitats – especially coastal *Eucalyptus* tall open forests – but since Cane Toads the most suitable habitats are rocky areas (Van Dam et al. 2002). Prime habitat in the NT consists of rocky sandstone escarpments (Braithwaite & Griffiths 1994). **Distribution:** Historically occurred from Borroloola in the south-east as far west as the NT/WA border (Woinarski et al. 2007). Dramatic range contraction associated with Cane Toad invasion. Now occurs across northern Australia in five regional populations – including the Top End in the NT.	**NONE** • No suitable rocky sandstone escarpments within the survey area, nor preferred coastal *Eucalyptus* tall open forest. • Closest known occurrences are approx. 120km NE & W in 1986. • The survey area is outside the distribution of the species. • This species has experienced a significant reduction in population sizes and ranges since the invasion of Cane Toads.
	Braithwaite, R.W. and Griffiths, A.D. (1994). Demographic variation and range contraction in the Northern Quoll, *Dasyurus hallucatus* (Marsupialia: Dasyuridae). *Wildlife Research,* Vol. 21, pp. 203-218. Van Dam, R.A., Walden, D.J. and Begg, G.W. (2002). *A preliminary risk assessment of cane toads in Kakadu National Park*. Supervising Scientist Report 164, Darwin, Northern Territory. Woinarski, J.C.Z., Rankmore, B.R., Fisher, A. and Milne, D. (2007). *The natural occurrence of northern quolls Dasyurus hallucatus on islands of the Northern Territory: assessment of refuges from the threat posed by cane toads Bufo marinus.* Report to Natural Heritage Trust.			
Golden Bandicoot *Isoodon auratus (auratus)*	VU	EN	**Habitat:** Mainly in heathland and shrubland on sandstone sheets, avoiding vegetation with greater tree cover (Palmer et al. 2012; Southgate et al. 1996). **Distribution:** Formerly across most of northern, central and western Australia (across a broad range of habitats), but now only recorded population on mainland Australia is within the Kimberley. Within the NT, confined to the offshore islands of Arnhem Land. The only records from mainland NT are from the north-east corner of Arnhem Land between 1950 and 1980 (Palmer et al. 2012). Now extinct on the mainland except in a few locations in the north-west Kimberley (TSSC 2015).	**NONE** • Extinct on the mainland NT.

	Palmer, C., Woinarski, J. and Hill, B. (2012). *Threatened Species of the Northern Territory - Golden Bandicoot - Isoodon auratus*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0017/205505/golden-bandicoot.pdf [Accessed 23 March 2017]. Southgate, R., Palmer, C., Adams, C., Masters, M., Triggs, B. and Woinarski, J. (1996). Population and habitat characteristics of the Golden Bandicoot (*Isoodon auratus*) on Marchinbar Island, Northern Territory. *Wildlife Research*, Vol. 23, pp. 647-664. Threatened Species Scientific Committee (TSSC) (2015). *Approved Conservation Advice for Isoodon auratus auratus (golden bandicoot (mainland))*. Canberra: Department of the Environment. [online] Available at:http://www.environment.gov.au/biodiversity/threatened/species/pubs/66665-conservation-advice-01102015.pdf [Accessed 23 March 2017].			
Ghost Bat *Macroderma gigas*	VU	-	**Habitat:** Ranging from the arid Pilbara (WA) to tropical savannah woodlands and north Qld rainforests (TSSC 2016). Permanent roost sites are generally deep natural caves or disused mines (TSSC 2016). **Distribution:** Geographically-disjunct colonies occur in the Pilbara and Kimberley in WA, NT north of approximately 17º latitude (including Elcho Island and Groote Eylandt), the Gulf of Carpentaria, eastern Qld from Cape York to near Rockhampton, and western Qld (including Riversleigh and Camooweal districts) (TSSC 2016). Distribution likely influenced by the availability of suitable caves and mines for roost sites (Ward & Milne 2016). Only 14 breeding sites known (Worthington Wilmer 2012). In arid Australia, including southern NT until the early 1960's (Ward & Milne 2016).	**LOW** • No suitable permanent roost sites within the survey area. • No occurrences close to survey area.
	Milne, D. and Ward, S. (2016). *Threatened Species of the Northern Territory – Ghost Bat - Macroderma gigas*. Northern Territory Department of Environment and Natural Resource. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0010/376138/ghost-bat.pdf [Accessed 20 April 2017]. Threatened Species Scientific Committee (2016). *Approved Conservation Advice for Macroderma gigas (ghost bat)*. Canberra: Department of the Environment. Available at:http://www.environment.gov.au/biodiversity/threatened/species/pubs/174-conservation-advice-05052016.pdf [Accessed 20 April 2017]. Worthington Wilmer, J. (2012). Ghost Bat Macroderma gigas. In: Curtis et al. (eds.). *Queensland's Threatened Animals*. CSIRO, Canberra: pp. 382-383.			
Greater Bilby *Macrotis lagotis*	VU	VU	**Habitat:** In the NT, hummock grasslands on sandy soils with a preference for palaeo-drainage lines (Southgate 1990). Has large foraging area and will move home range in search for food (Johnson 2008). **Distribution:** Historically widespread in arid Australia. Currently arid WA, the Tanami Desert in the NT and south-western Qld (Woinarski et al. 2014).	**NONE** • No suitable hummock grasslands on sandy soils within the survey area. • There are no nearby records – survey area is outside of historic extent.
	Johnson, K.A. (2008). Bilby Macrotis lagotis. In: Van Dyck, S. and Strahan, R. (eds.). *Mammals of Australia*. Third Edition. Reed New Holland, Queensland Government, Queensland Museum: pp. 191-193. Southgate, R. (1990). Habitat and diet of the greater bilby *Macrotis lagotis* Reid (Marsupalia: Peramelidae). In: Seebeck et al. (eds.). *Bandicoots and Bilbies*. Surrey Beatty & Sons, Sydney, NSW. Woinarski, J., Burbidge, A. & Harrison, P. (2014). *The Action Plan for Australian Mammals 2012*. CSIRO Publishing: pp. 203-205.			
Golden-backed Tree-rat *Mesembriomys macrurus*	VU	CR	**Habitat:** In the NT, little known of the ecology apart that all three records were from riverine vegetation. In the Kimberley, known to occur in open *Eucalyptus* forests with tussock grass understorey, rainforest patches, sandstone screes, beaches, and black soil plains (Woinarski et al. 2012). **Distribution:** Historically, known to have occurred in three localities in the NT (Parker 1973) with no new records in the last 30 years. In 1993, reportedly spotted in Kakadu National Park; however, further surveys of suitable habitats in the NT failed to locate the species (Lee 1995). Now only known to occur in some areas of the north-western Kimberley and associated offshore islands (Palmer et al. 2003).	**NONE** • Locally extinct.
	Lee, A.K. (1995). *The Action Plan for Australian Rodents*. Australian Nature Conservation Agency, Endangered Species Program, Canberra.			

	Palmer, C., Taylor, R. & Burbidge, A. (2003). *Recovery plan for the Golden Bandicoot Isoodon auratus and golden-backed tree-rat Mesembriomys macrurus 2004-2009*. Northern Territory Department of Infrastructure Planning and Environment, Darwin. Parker, S.A. (1973). An annotated checklist of the native land mammals of the Northern Territory. *Records of the South Australian Museum*, Vol. 16, pp. 1-57. Woinarski, J.C.Z., Palmer, C. & Hill, B. (2012). *Threatened Species of the Northern Territory - Golden-backed tree-rat - Mesembriomys macrurus*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0006/205476/golden-backed-tree-rat.pdf [Accessed 20 April 2017].			
Northern Hopping-Mouse *Notomys aquilo*	VU	VU	**Habitat:** Most often sandy substrates, seemingly favouring coastal sand dunes and sand sheets with a cover of tussock grass or heath. Also shrubland, *Eucalyptus* open forest, and the margins of coastal rainforest thickets (Woinarski 2004; Woinarski & Flannery 2008). **Distribution:** Restricted to the NT – mostly Groote Eylandt, but also central north-east Arnhem Land (Woinarski & Ward 2012). No confirmed records from the Australian mainland for at least 10 years (Woinarski et al. 2014).	**NONE** • Species favours coastal sand dunes and sandsheets under tussock grass/heath, of which there is none within the survey area. • Closest known occurrence is more than 150km NE.
	Woinarski, J., Burbidge, A. & Harrison, P. (2014). *The Action Plan for Australian Mammals 2012*. CSIRO Publishing: pp. 609-611. Woinarski, J.C.Z. & Flannery, T.F. (2008). Northern Hopping-mouse. in Van Dyck, S. & Strahan, R. (eds.) *The Mammals of Australia*, *3rd Edition*. Reed New Holland, Sydney. Woinarski, J.C.Z. (2004). *National Multi-species Recovery Plan for the Carpentarian Antechinus Pseudantechinus mimulus, Butler's Dunnart Sminthopsis butleri and Northern Hopping-mouse Notomys aquilo, 2004 - 2008*. Department of the Environment and Heritage, ACT. [online] Available at: https://www.environment.gov.au/system/files/resources/dfb8a0ed-9e3e-4315-9e35-e28236ee96ba/files/p-mimulus-s-butleri-n-aquilo.pdf [Accessed 20 April 2017]. Woinarski, J. and Ward, S. (2012). *Threatened Species of the Northern Territory – Northern Hopping Mouse – Notomys aquilo*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0019/205516/northern-hopping-mouse.pdf [Accessed 20 April 2017].			
Southern Marsupial Mole *Notoryctes typhlops*	-	VU	**Habitat:** Sandy deserts mostly associated with dunes, sandy plains and river flats (Pavey 2015). **Distribution:** Central WA, northern SA and southern NT. Seems to be confined to the southern and western sections of the NT (Benshemesh & Schultz 2008) where has been found as far north as Barrow Creek (Pavey 2015).	**NONE** • No sandy deserts utilised by this species are present within the survey area. • Closest known occurrence is more than 250km SW.
	Pavey, C. (2015). *Threatened Species of the Northern Territory - Southern Marsupial Mole - Notoryctes typhlops*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0016/205522/southern-marsupial-mole.pdf [Accessed 23 March 2017]. Benshemesh, J. & Schultz, M. (2008). *Survey of the underground signs of marsupial moles in the WA Great Victoria Desert*, Tropicana Joint Venture and the Department of Natural Resources, Environment and the Arts, NT Government			
Carpentarian Antechinus *Pseudantechinus mimulus*	VU	-	**Habitat**: In the NT, sloping sandstone hills with boulders, pavement, outcrops and rocky surface, with open woodland of *Eucalyptus tetrodonta* and *E. aspera*, and a dense understorey and ground cover of *Plectrachne pungens* (DoE 2017). **Distribution:** In the NT, the Sir Edward Pellew island group and Pungalina-Seven Emu (mainland reserve south-west of Borroloola (Woinarski & Ward 2012). Also a few records around Mount Isa in Qld (DoE 2017).	**LOW** • Only a small area of rocky outcropping which has been recently burnt and is unlikely to provide sufficient habitat. • Survey area is towards the edge of the species' distribution and outside areas of known populations.
	Department of the Environment (2017). *Pseudantechinus mimulus — Carpentarian Antechinus.* Species Profile and Threats Database. Department of the Environment, Canberra. [online] Available at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=59283 [Accessed 21 April 2017]. Woinarski, J.C.Z. and Ward, S. (2012). *Threatened Species of the Northern Territory - Carpentarian Antechinus - Pseudantechinus mimulus*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0005/376133/carpentarian-antechinus.pdf [Accessed 20 April 2017].			
Pale Field-rat *Rattus tunneyi*	-	VU	**Habitat:** Historically occurred in a wide range of habitats, but now primarily in dense vegetation along creeks (Aplin et al. 2008).	**LOW** • Limited dense vegetation along ephemeral

			Distribution: Higher rainfall areas of northern Australia, extending from Kimberley in WA to south-eastern Qld, including the Top End of the NT (Braithwaite & Griffiths 1996).	watercourses and waterholes is unlikely to provide suitable habitat. • Survey area is located on the edge of known range. • Two occurrences approx. 100km N and W (1999 and 1982), others are >150km NE.
	Aplin, K., Braithwaite, R. and Baverstock, P. (2008). Pale Field-rat: *Rattus tunneyi*. In: Van Dyck, S. and Strahan, R. (eds.). *The Mammals of Australia (3rd Edition)*. Reed New Holland, Sydney, NSW. Braithwaite, R. and Griffiths, A. (1996). The paradox of *Rattus tunneyi*: endangerment of a native pest. *Wildlife Research,* Vol. 23, pp. 1-21.			
Bare-rumped Sheathtail Bat *Saccolaimus saccolaimus (nudicluniatus)*	VU	-	**Habitat:** In the NT, specimens have been collected from Pandanus woodland fringing the sedgelands of the South Alligator River and *Eucalyptus* tall open forests (Friend & Braithwaite 1986; Churchill 1998). Predominantly found throughout the monsoonal tropics. Most records occur within near-coastal habitats with one recent exception (Jasper Gorge) 150 km inland (Woinarski et al. 2014). **Distribution:** Widely distributes from India through south-eastern Asia to the Solomon Islands including north-eastern Qld and the NT. The north-eastern Australian population is described as the subspecies *S. s. nudicluniatus*, although it is not clear whether this should be applied to the NT (Milne & Woinarski 2006).	**LOW** • Dry open woodlands and grasslands area unlikely to provide suitable habitat for the species. • Generally, prefers habitat closer to the coast. • One occurrence in 2001 about 150km NE, no others nearby. • Survey area is on the edge of known range.
	Churchill, S. (1998). *Australian Bats*. Reed New Holland, Sydney. Friend, G.R. and Braithwaite, R.W. (1986). Bat fauna of Kakadu National Park, Northern Territory. *Australian Mammalogy*, Vol. 9, pp. 43-52. Milne, D. and Woinarski, J. (2006). *Threatened Species of the Northern Territory - Bare-rumped Sheathtail Bat - Saccolaimus saccolaimus*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0007/376117/bare-rumped-sheathtail-bat.pdf [Accessed 21 April 2017]. Woinarski, J., Burbidge, A. and Harrison, P. (2014). *The Action Plan for Australian Mammals 2012*. CSIRO Publishing: pp. 511-514.			
Carpentarian Rock-rat *Zyzomys palatalis*	EN	CR	**Habitat:** Restricted to sandstone gorges and escarpments containing a core of dry or wet rainforest vegetation, mixed with woodland, scree slopes and permanent water, surrounded by savannah woodlands (Puckey & Woinarski 2006). **Distribution:** Restricted to the NT, where known only from five locations within a radius of 35 km (Puckey 2003) at Wollogorang Station in the Gulf of Carpentaria (Kitchener 1989).	**NONE** • No suitable sandstone gorge or escarpment which would provide suitable habitat. • No proximate records.
	Kitchener, D.J. (1989). Taxonomic appraisal of Zyzomys (Rodentia, Muridae) with descriptions of two new species from the Northern Territory, Australia. *Records of the Western Australian Museum*, Vol. 14, pp. 331-373. Puckey, H. (2003). Additional records of the Carpentarian rock-rat *Zyzomys palatalis* at Redbank, close to the type locality. *Northern Territory Naturalist*, Vol. 17, pp. 43-45. Puckey, H. and Woinarski, J. (2006). *Threatened Species of the Northern Territory - Carpentarian Rock-rat - Zyzomys palatalis*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0008/205478/carpentarian-rock-rat.pdf [Accessed 21 April 2017].			
REPTILES (TERRESTRIAL)				
Plains Death Adder *Acanthophis hawkei*	VU	VU	**Habitat:** Floodplains and cracking soil plains (Webb et al. 2002). **Distribution**: Habitat mapping suggests the potential geographic range extends from western Qld, across the north of the NT to north-eastern WA. Fragmented populations occur in the Mitchell Grass Downs of western Qld, the Barkly Tablelands on the NT/Qld border and east of Darwin in the NT	**LOW** • No proximate records and at the edge of the species' range. • Potentially-suitable cracking clay habitat occurs in

			(TSSC 2012).	alluvial plains within survey area.
	Webb, J.K., Christian, K.A. & Fisher, P. (2002). Fast growth and early maturation in a viviparous sit-and-wait predator, the northern death adder (*Acanthophis praelongus*) from tropical Australia. *Journal of Herpetology*, Vol. 36, no. 3, pp. 505-509. Threatened Species Scientific Committee (2015). *Approved Conservation Advice – Acanthophis hawkei – Plains Death Adder.* Canberra: Department of the Environment. [online] Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/83821-conservation-advice.pdf [Accessed 21 April 2017].			
Mertens' Water Monitor *Varanus mertensi*	-	VU	**Habitat:** Semi-aquatic, occupying edges of freshwater watercourses and lagoons, but seldom seen far from water (Christian 2004). **Distribution:** Across far northern Australia from the western Cape York Peninsula in Qld to the Kimberley in WA (Christian 2004). Widespread in the NT, occupying all of the Top End river systems (Ward et al. 2006). Susceptible to ingesting toxic Cane Toads resulting in reduced abundance (Griffiths & McKay 2007).	**MEDIUM** • Record south of Carpentarian Highway, near to project area. • Wide distribution and potential habitat within the survey area.
	Christian, K. (2004). Varanus mertensi. In: Pianka et al. (eds.). *Varanoid lizards of the world*. Indiana University Press, Bloomington, Indianapolis. Griffiths, A.D. and McKay (2007). Cane toads reduce the abundance and site occupancy of Merten's water monitor (Varanus mertensi). *Wildlife Research,* Vol. 34, pp. 609-615. Ward, S., Woinarski, J., Griffiths, T. and McKay, L. (2006). *Threatened Species of the Northern Territory - Mertens Water Monitor - Varanus mertensi*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0018/206460/mertens-water-monitor.pdf [Accessed 1 May 2018].			
Mitchell's Water Monitor *Varanus mitchelli*	-	VU	**Habitat:** Semi-aquatic and arboreal, inhabiting margins of watercourses, swamps and lagoons (Ward 2012). **Distribution:** Top End of the NT and Kimberley in WA (Schultz & Doody 2004). In the NT, recorded in most catchments flowing into the Timor Sea, Arafura Sea and the Gulf of Carpentaria (Ward 2012).	**LOW** • Ephemeral watercourses and limited pools are unlikely to provide suitable habitat. • Survey area at the edge of known range.
	Doody, J.S., Green, B., Rhind, D., Castellano, C., Sims, R. and Robinson, T. (2009). Population-level declines in Australian predators caused by an invasive species. *Animal Conservation*, Vol. 12, pp. 46-53. Schultz, T. and Doody, S. (2004). Varanus mitchelli. In: Pianka et al. (eds.). *Varanoid lizards of the world*. Indiana University Press, Bloomington, Indianapolis. Ward, S. (2012). *Threatened Species of the Northern Territory - Mitchell's Water Monitor - Varanus mitchelli*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0019/206461/mitchells-water-monitor.pdf [Accessed 21 April 2017].			
Floodplain Monitor *Varanus panoptes*	-	VU	**Habitat:** Broad range of habitats from coastal beaches to savannah woodlands (Christian 2004). Also common throughout floodplains grasslands and a variety of native woodlands (Ward et al. 2012). **Distribution:** Across northern Australia from the Kimberley in WA to Cape York Peninsula, and southwards through most of Qld. In the NT, recorded across most of the Top End and the Gulf Region (Christian 2004). Experienced significant declines due to cane toad poisoning (Doody et al. 2009).	**LOW** • Open woodlands within the survey area may provide potential habitat. • Survey area is at the edge of known range. • Closest known occurrence is more than 100km E and NW of survey area and prior to 1990.
	Christian, K. (2004). Varanus panoptes. In: Pianka et al. (eds). *Varanoid lizards of the world*. Indiana University Press, Bloomington, Indianapolis. Doody, J.S., Green, B., Rhind, D., Castellano, C., Sims, R. and Robinson, T. (2009). Population-level declines in Australian predators caused by an invasive species. *Animal Conservation*, Vol. 12, pp. 46-53. Ward, S., Woinarski, J., Griffiths, T. & McKay, L. (2012). *Threatened Species of the Northern Territory - Yellow Spotted Monitor, Northern Sand Goanna, Floodplain Monitor - Varanus panoptes.* Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0006/206466/floodplain-monitor.pdf [Accessed 7 April 2017].			

REPTILES (MARINE)				
Gulf Snapping Turtle *Elseya lavarackorum*	EN	-	**Habitat:** Large rivers and their associated overflow lagoons and oxbow lakes (Cogger 2000; Woinarski 2006). Found in deeper permanent pools most often with muddy, sandy or rocky bottoms. Also found in the middle reaches of rivers, upstream of saline regions and downstream of escarpments, including plunge pools. Steep rocky gorges, and river reaches with intact river banks seem to be preferred habitats (Thomson et al. 1997). **Distribution:** Rivers in far eastern NT and far western Qld which discharge into the Gulf of Carpentaria. In the NT this includes the Roper, Limmen Bight, Robinson and Nicholson Rivers (DoE 2017).	**NONE** • No large rivers preferred by this species are present within the survey area. • No proximate records.
	Cogger, H.G. (2000). *Reptiles and Amphibians of Australia - 6th edition*. Reed New Holland, Sydney, NSW. Department of the Environment (2017). *Elseya lavarackorum - Gulf Snapping Turtle.* Species Profile and Threats Database, Department of the Environment, Canberra. [online] Available at: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=67197 [Accessed 21 April 2017]. Thomson, S., White, A. and Georges, A. (1997). Re-evaluation of *Emydura lavarackorum*: identification of a living fossil. *Memoirs of the Queensland Museum*, Vol. 42 (No. 1), pp. 327-336. Woinarski, J. (2006). *Threatened Species of the Northern Territory - Gulf Snapping Turtle - Elseya lavarackorum.* Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0008/376181/gulf-snapping-turtle.pdf [Accessed 21 April 2017].			
FISH				
Freshwater or Largetooth Sawfish *Pristis pristis*	VU	VU	**Habitat:** Tropical marine and estuarine habitats, entering estuarine or fresh waters to breed during the wet season and moving into marine waters following the wet season (Peverell 2005). **Distribution:** Circumtropical, with distinct populations in the eastern Atlantic, western Atlantic, eastern Pacific and Indo-West Pacific – including northern Australia (TSSC 2014). In the NT, reported in Adelaide, Victoria, Daly, East and South Alligator, Goomadeer, Roper, McArthur, Wearyan and Robinson Rivers (TSSC 2014).	**NONE** • No marine / estuarine habitat used by this species is present within the survey area. • No proximate records.
	Peverell, S.C. (2005). Distribution of sawfishes (Pristidae) in the Queensland Gulf of Carpentaria, Australia, with notes on their ecology. *Environmental Biology of Fishes,* Vol. 73, pp. 391-402. Threatened Species Scientific Committee (2014). *Approved Conservation Advice - Pristis pristis (largetooth sawfish).* Canberra: Department of the Environment. In effect under the EPBC Act from 11-April-2014. [online] Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/60756-conservation-advice.pdf [Accessed 26 April 2017].			
FLORA				
Swordfern *Macrothelypteris torresiana*	-	EN	**Habitat:** Sheltered sandstone gorges associated with springs and groundwater seepages (Cowie & Westaway 2012). **Distribution:** Isolated populations in northern WA, eastern Qld, north-eastern NSW and the NT (two locations on Wollogorang Station in the Gulf region, adjacent to the Qld border) (Cowie & Westaway 2012). There are substantial areas of potentially-suitable habitat in Western Arnhem Land that are poorly surveyed at the scale and intensity necessary to exclude the possibility that more subpopulations exist; however, the chance of finding additional subpopulations in that area appears relatively low (Cowie & Westaway 2012).	**NONE** • The survey area contains no sandstone gorges that this species prefers. • No proximate records.
	Cowie, I. and Westaway, J. (2012*). Threatened Species of the Northern Territory - Macrothelypteris torresiana*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0006/208473/macrothelypteris-torresiana.pdf [Accessed 28 April 2017].			

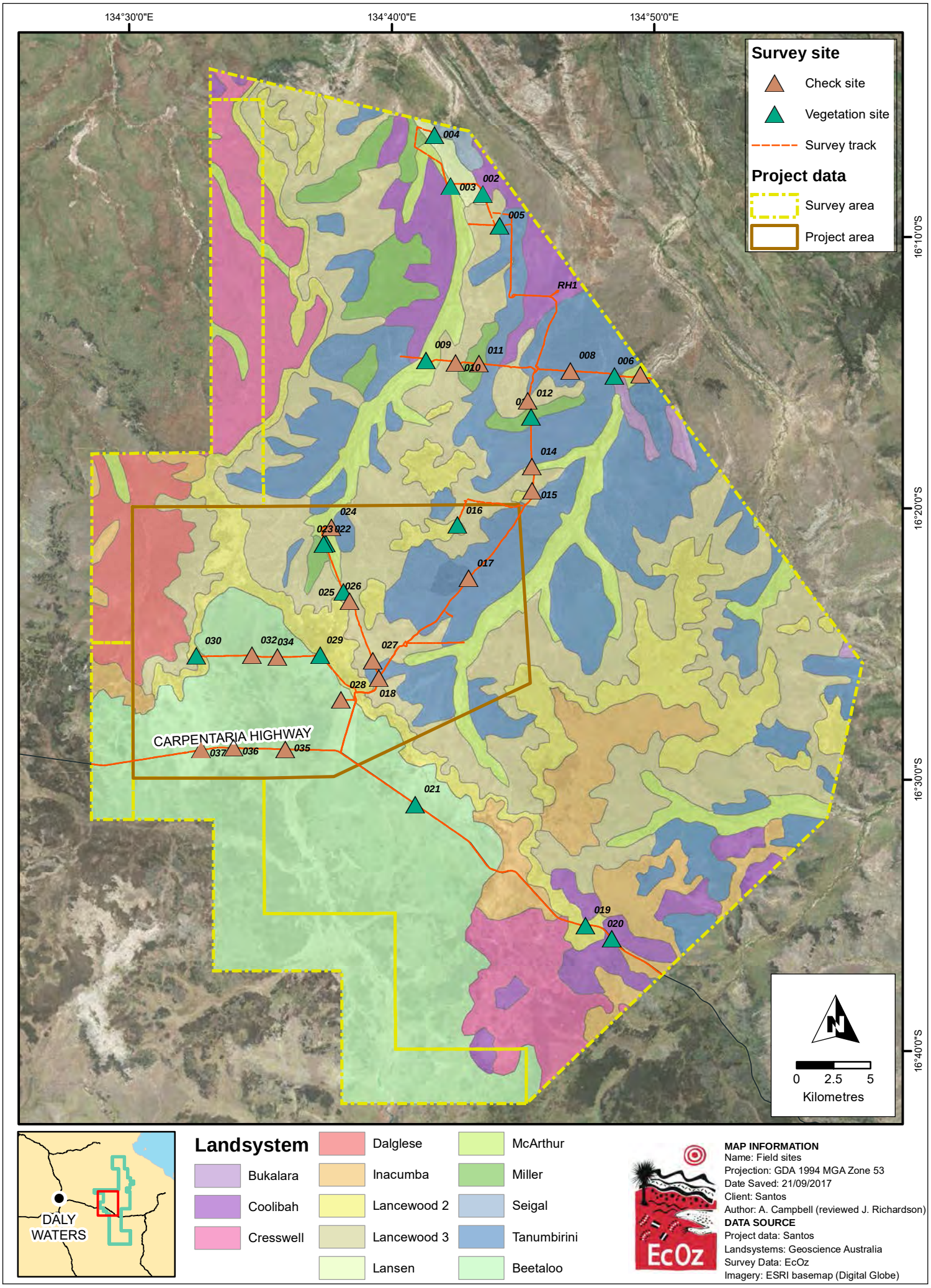
APPENDIX C LIKELIHOOD OF OCCURRENCE ASSESSMENT FOR MIGRATORY SPECIES WITHIN SURVEY AREA

Species	Species details	Likelihood of occurrence
MIGRATORY MARINE BIRDS		
Apus pacificus **Fork-tailed Swift**	**Habitat:** Almost exclusively aerial. Mostly occurs over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh. Catches insects on the wing (DoE 2017). **Distribution:** A non-breeding visitor to all states and territories of Australia. Breeds in Siberia and migrates southward during the northern winter (DoE 2017).	**MEDIUM (above the project area)** • Given the broad distribution and wide ranging nature of *Apus pacificus* it is likely to be present (at some time period) within/over the project area. • The project area is within the species' distribution. • The dry, open grasslands and riparian woodland occurring in the project area would provide suitable habitat for this species.
	Department of Environment (DoE) 2017, *Apus pacificus* in Species Profile and Threats Database, Department of the Environment, Canberra, viewed September 2017, http://www.environment.gov.au/.	
MIGRATORY MARINE SPECIES		
Crocodylus porosus **Saltwater Crocodile**	**Habitat:** Mostly occurs in tidal rivers, coastal floodplains and channels, billabongs and swamps (Webb et al. 1987) up to 150 km inland from the coast **Distribution:** Northern Australia coastal waters, estuaries, lakes, inland swamps and marshes.	**NONE** • No major river systems utilised by this species occur within the project area. • The project area is over 200km inland from the coast.
MIGRATORY TERRESTRIAL SPECIES		
Cecropis daurica **Red-rumped Swallow**	**Habitat:** Predominately forages over wetlands or open areas such as golf courses. Perches on bare branches or wires (DoE 2017). **Distribution:** Vagrant to Australia; may be found between December and February in around the Top End including Darwin (DoE 201).	**LOW** • Vagrant to Australia • The woodland vegetation of the project area is unlikely to provide suitable foraging habitat for the species, which forages over wetlands.
	Department of Environment (DoE) 2017, *Cecropis daurica* in Species Profile and Threats Database, Department of the Environment, Canberra, viewed September 2017, http://www.environment.gov.au/.	

Species	Species details	Likelihood of occurrence
Cuculus optatus **Oriental Cuckoo**	**Habitat:** Uses a range of vegetated habitats such as monsoon rainforest, wet sclerophyll forest, open woodlands and appears quite often along edges of forests, or ecotones between forest types (DoE 2017). **Distribution:** Widespread in Top End from Darwin, north to Melville and South Goulburn Islands, east to Gove Peninsula, Groote Eylandt and Sir Edward Pellew Group and south to Roper River (DoE 2017).	**LOW** • The project area is within the distribution of the species • The open woodland vegetation and creek line vegetation within the project area does not provide suitable habitat for the species
	Department of Environment (DoE) 2017, *Cuculus optatus* in Species Profile and Threats Database, Department of the Environment, Canberra, viewed September 2017, http://www.environment.gov.au/.	
Hirundo rustica **Barn Swallow**	**Habitat:** Found above open vegetated areas including farmland, sports grounds, native grasslands and airstrips as well as over open water such as billabongs, lagoons, creeks and sewage treatment plants. Perch on bare branches or wires, and gather in flocks to during the day, and roost at night perched in vegetation, usually tall wetland grasses (DoE 2017). **Distribution:** Found between December and February in around the Top End including Darwin (DoE 2017).	**LOW** • Vagrant to the area. • Nearest records > 200km to the NE
	Department of Environment (DoE) 2017, *Hirundo rustica* in Species Profile and Threats Database, Department of the Environment, Canberra, viewed September 2017, http://www.environment.gov.au/.	
Motacilla cinerea **Grey Wagtail**	**Habitat:** Has a strong association with water with all confirmed Australian records being associated with water; especially creeks, rivers and waterfalls (DoE 2017). **Distribution:** Scarce but regular visitor to northern Australia, including the Top End of the Northern Territory around the greater Darwin region (DoE 2017).	**LOW** • The species is a vagrant visitor to Australia. • The project area is south of the known distribution of the species in Australia. • Creek areas within the project area may provide limited suitable habitat for the species. • One record (2002) from the Roper River (>150km north of project area)
	Department of Environment (DoE) 2017, *Motacilla cinerea* in Species Profile and Threats Database, Department of the Environment, Canberra, viewed September 2017, http://www.environment.gov.au/.	
Motacilla flava **Yellow Wagtail**	**Habitat:** Typically inhabit open grassy flats near water, including open areas with low vegetation such as grasslands, airstrips, pastures, sports fields; damp open areas such as muddy or grassy edges of wetlands, rivers, irrigated farmland, dams, waterholes; sewage farms, sometimes utilise tidal mudflats and edges of mangroves (DEE, 2015). **Distribution:** Regular summer visitor to Northern Australia including the greater Darwin area (DEE, 2015).	**LOW** • The vegetation of the project area is unlikely to provide limited suitable open areas for foraging of the species. • The project area is south of the known distribution of the species in Australia.
	Department of Environment (DoE) 2017, Apus pacificus in Species Profile and Threats Database, Department of the Environment, Canberra, viewed September 2017, http://www.environment.gov.au/.	

Species	Species details	Likelihood of occurrence
MIGRATORY WETLAND SPECIES		
Actitis hypoleucos **Common Sandpiper**	**Habitat:** In Australia, the species inhabits mainly coastal but some inland wetlands where the species forages in shallow water on mudflats (DoE 2017). **Distribution:** Widespread across coastal regions of the Top End of the Northern Territory, and widespread but scattered inland, mostly north of Tennant Creek (DoE 2017).	**LOW** • There is no suitable habitat within the project area for the species.
	Department of Environment (DoE) 2017, *Actitis hypoleucos* in Species Profile and Threats Database, Department of the Environment, Canberra, viewed September 2017, http://www.environment.gov.au/.	
Calidris acuminata **Sharp-tailed Sandpiper**	**Habitat:** Prefers muddy edges of shallow wetlands, with inundated low vegetation (DoE 2017). **Distribution:** Widespread summer migrant to coastal and inland Australia. (DoE 2017)	**LOW** • There is little suitable habitat within the project area for the species.
	Department of Environment (DoE) 2017, *Calidris acuminata* in Species Profile and Threats Database, Department of the Environment, Canberra, viewed September 2017, http://www.environment.gov.au/.	
Calidris melanotos **Pectoral Sandpiper**	**Habitat:** Shallow fresh waters, often with low grass or other herbage, flooded pastures, sewage ponds, occasionally tidal areas, saltmarshes. (Pizzey & Knight, 2012) **Distribution:** Widespread, common summer migrant Australia; mostly coastal. (Pizzey & Knight, 2012) In the Northern Territory (NT), the Pectoral Sandpiper is found at Darwin and Alice Springs (Higgins & Davies 1996).	**LOW** • Given the preference for wetland areas, there is little suitable habitat within the project area for this species.
	Department of Environment (DoE) 2017, *Calidris melanotos* in Species Profile and Threats Database, Department of the Environment, Canberra, viewed September 2017, http://www.environment.gov.au/.	
Charadrius veredus **Oriental Plover**	**Habitat:** After moving from coastal environments *Charadrius veredus* usually inhabit flat, open, grasslands, where short grass is interspersed with hard, bare ground (Boekel 1980; Carruthers 1966; Pedler 1982) **Distribution:** Oriental Plover is a non-breeding visitor to Australia, where the species occurs in both coastal and inland areas, mostly in northern Australia. It is found on black soil plains in the Northern Territory and Queensland (DoE, 2016).	**MEDIUM** • The project area is within the species range. • The grasslands (and black soil plains) within the project area represent suitable habitat.
	Department of Environment (DoE) 2017, *Charadrius veredus* in Species Profile and Threats Database, Department of the Environment, Canberra, viewed September 2017, http://www.environment.gov.au/.	

APPENDIX D MAP OF DESKTOP ASSESSMENT SURVEY SITES



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ17088 - Santos Rehab and Ecology\01 Project Files\Ecology report maps\Field sites.mxd

Map showing survey sites and land systems

Appendix D: Aboriginal and Non-indigenous Archaeological Assessment

An Aboriginal and non-Indigenous archaeological assessment of proposed works in EP161, Northern Scope, McArthur Basin, Northern Territory

A report to Santos Ltd

by

Johan Kamminga
Allan Lance

Heritage Consulting Australia Pty Ltd
GPO Box 2677
Canberra ACT 2601

March 2019

Table of Contents

Executive summary

Heritage Consulting Australia Pty Ltd (HCA) has been engaged by Santos Ltd to undertake a cultural heritage (archaeological) survey and assessment of Aboriginal and non-Indigenous heritage for the Tanumbirini North and Inacumba North areas in Exploration Permit 161 (EP161) in the Northern Territory's McArthur Basin.

The area is to be subject to a further exploration program (the Northern Works Program) seeking to evaluate potential gas reserves that were identifie during exploration first conducted in 2013 with subsequent seismic survey and drilling undertaken. In the earlier seismic study, 500km of 2D seismic data were acquired to map the regional sub-surface geology and an exploration well (Tanumbirini 1) was drilled in June 2014.

The area under investigation is part of the Exploration Permit Area 161, situated 350 km south-east of Katherine. The location where the next phase of exploration is to occur is near the previously drilled Tanumbirini well, located 12 km north of the Carpentaria Highway (Highway 1) and approximately 135 km east of the township of Daly Waters at the junction of the Stuart Highway and Highway 1.

The further work program will entail a 2D seismic survey along a 10 km transect through the Tanumbirini North area, a drilling program (initially one horizontal well) in the same area, and a drilling program (initially one vertical and one horizontal well) in the Inacumba North area. There will be additional activities associated with this program including upgrading of access tracks to facilitate the entry and egress of vehicles during the seismic survey program. The Inacumba North area is situated ~15 km east of the Tanumbirini North location. At both locations where drilling is to occur there will be impacts within an area of approximately 200 m of the hole centre to accommodate drilling infrastructure, in addition to upgrades to access tracks and safe access to the Carpentaria Highway.

An archaeological field assessment was carried out by archaeologist Dr Johan Kamminga over 3 days in early March 2019, adopting a methodology consistent with the Northern Territory Cultural Heritage Act, 2011. The proposed seismic survey line route, locations of proposed upgrades to existing roads and tracks, well locations and the general project area were intensively examined for traces of prior Aboriginal habitation and resource use, and non-Indigenous settlement, to allow the development of appropriate management strategies to ensure the protection of the region's cultural heritage values.

This archaeological study did not address places of contemporary Indigenous significance, as defined by the *Northern Territory Aboriginal Sacred Sites Act,* 1989. The relevant statutory body for the project area is the Northern Land Council which has previously carried out an assessment in the project area and its vicinity. Two recorded sites of special Aboriginal significance were identified during this Sacred Site assessment and these sites have been protected from any potential impacts by broad exclusion zones. These Sacred Sites were not visited during the present study, nor were the exclusion zones entered.

Site register search and archaeological sensitivity modelling

Prior to the field inspection of the project area, a review of previously located sites, as recorded in the Northern Territory Heritage Register, was undertaken. The mapping of these sites and the development of models of Aboriginal site distribution that this permits, revealed the most archaeologically sensitive zones throughout the project area. This modelling assisted with the formulation of a field survey strategy to identify locations most likely to contain evidence of prior Aboriginal activity and cover any areas that may experience ground disturbance during the planned explora-

tion and drilling program.

No Aboriginal, Macassan or non-Aboriginal archaeological places, sites or relics had previously been recorded within the project area. The closest registered Aboriginal archaeological sites or relics are at least 7 km distant from the project area. These are mostly isolated stone artefacts or stone artefact scatters. There are, however, restricted Aboriginal rock art sites 18km from the project area. These are found in rocky escarpments, a landform that does not occur in the area where construction activities are to occur.

Field investigation

The archaeological survey and assessment focused on the identification of Aboriginal, Macassan and other non-Aboriginal archaeological places, sites and relics as defined by the *Northern Territory Heritage Act,* 2011.

The field survey covered all environmental zones within the project area. The areas that were investigated included the 10km long route of a proposed seismic line that traversed the Tanumbirini North project area; areas around the proposed Inacumba pilot well location, and around existing infrastructure including roads and well leases; and a number of other locations in and around the project area. The site inspection assisted with an understanding of the distribution of items of Aboriginal cultural heritage significance in this landscape.

Results

This archaeological field survey carried out as a core component of the archaeological assessment revealed no Aboriginal relics or sites (for example stone tools, former camp sites, or culturally modified trees), nor any non-Aboriginal relics or sites. This indicates that Aboriginal sites and relics are relatively sparse to very sparse within the more general area of northern Tanumbirini Station.

There is no indication that any Aboriginal archaeological or historical sites/relics will be encountered or impacted by proposed activities in this portion of EP161.

Conclusions

The results of this archaeological study indicated that there are no identifiable archaeological heritage constraints on proposed work activities in the project area. This includes any activities in the vicinity of the existing gas and water well, the proposed seismic line, the proposed Inacumba pilot well, and the proposed widening or other modification to access tracks, or turning areas along the Carpentaria Highway.

In the unlikely event that previously undetected items of Aboriginal or non-Indigenous cultural heritage are encountered in the project area during planned exploration or construction activities, these should be noted, assessed, recorded and avoided. If avoidance is impracticable, a further assessment should be undertaken to evaluate cultural heritage significance, and in consultation with the Heritage Branch of the Northern Territory Department of Tourism, Sport and Culture, decide on the most appropriate remediation measures.

1. Introduction

Heritage Consulting Australia Pty Ltd (HCA) has been engaged by Santos Ltd to undertake a cultural heritage (archaeological) survey and assessment of Aboriginal and non-Indigenous heritage for the Tanumbirini North and Inacumba North areas in Exploration Permit 161 (EP161) in the Northern Territory's McArthur Basin.

The area is to be subject to a further exploration program (the Northern Works Program) seeking to evaluate potential gas reserves that were identifie during exploration first conducted in 2013 with subsequent seismic survey and drilling undertaken. In the earlier seismic study, 500 km of 2D seismic data were acquired to map the regional sub-surface geology and an exploration well (Tanumbirini 1) was drilled in June 2014.

The area under investigation is part of the Exploration Permit Area 161, situated 350 km southeast of Katherine. The location where the next phase of exploration is to occur is near the previously drilled Tanumbirini well, located 12 km north of the Carpentaria Highway (Highway 1) and approximately 135 km east of the township of Daly Waters at the junction of the Stuart Highway and Highway 1. The location of the proposed works is shown in Figure 1.

The further work program will entail a 2D seismic survey along a 10 km transect through the Tanumbirini North area, a drilling program (initially one horizontal well) in the same area, and a drilling program (initially one vertical and one horizontal well) in the Inacumba North area. There will be additional activities associated with this program including upgrading of access tracks to facilitate the entry and egress of vehicles during the seismic survey program. The Inacumba North area is situated ~15 km east of the Tanumbirini North location. At both locations where drilling is to occur there will be impacts within an area of approximately 200 m of the hole centre to accommodate drilling infrastructure, in addition to upgrades to access tracks and safe access to the Carpentaria Highway.

An archaeological field assessment was carried out by archaeologist Dr Johan Kamminga over 3 days in early March 2019, adopting a methodology consistent with the Northern Territory *Cultural Heritage Act*, 2011. The proposed seismic survey line route, locations of proposed upgrades to existing roads and tracks, well locations and the general project area were intensively examined for traces of prior Aboriginal habitation and resource use, and non-Indigenous settlement, to allow the development of appropriate management strategies to ensure the protection of the region's cultural heritage values.

This archaeological study did not address places of contemporary Indigenous significance, as defined by the *Northern Territory Aboriginal Sacred Sites Act,* 1989. The relevant statutory body for the project area is the Northern Land Council which has previously carried out an assessment in the project area and its vicinity. Two recorded sites of special Aboriginal significance were identified during this Sacred Site assessment and these sites have been protected from any potential impacts by broad exclusion zones. These Sacred Sites were not visited during the

Figure 1. Location of the project area.

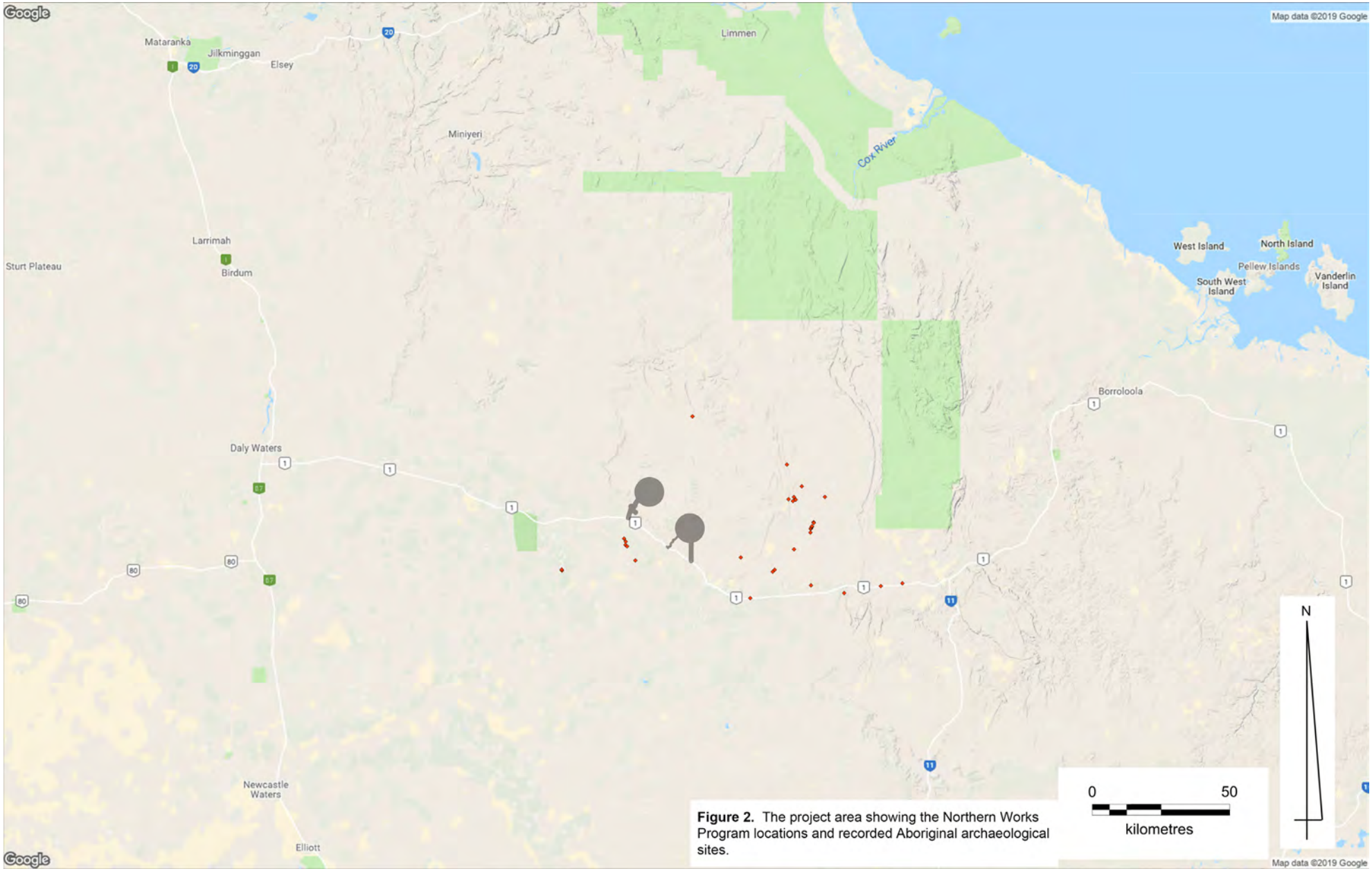


Figure 2. The project area showing the Northern Works Program locations and recorded Aboriginal archaeological sites.

present study, nor were the exclusion zones entered.

2. The project area

The project area lies within Santos exploration lease EP161, located on Tanumbirini Station, a 5,000 km^2 beef cattle grazing property located 420 km southeast of Katherine in the McArthur Basin, situated in the north-east of the Northern Territory. The project area is located within Barkly Shire and in NT Cadastral Parcel 701 of Arnold. The closest towns are Daly Waters (approximately 135 km to the west) and Borroloola (approximately 165 km to the east).

Cattle grazing is the primary activity on Tanumbirini Station, with some minor cropping around the station homestead. In the 1960s, pastoral activity was restricted to the northern, northeastern, and extreme western parts of the station, the remaining area being vegetated by scattered dense patches of lancewood (*Acacia shirleyi*) and “poor grass” (Paine 1963:1).

Tanumbirini Station Homestead settlement (the only permanent dwellings on the property) and the Santos project areas are accessed from the Carpentaria Highway, an all-weather public road constructed in 1959.

3. Environmental setting

3.1 Topography

The topography of the project area comprises gently undulating plain, moderately graded slopes in the order of 0-2°, and ephemeral drainage features such has creek channels and washouts (Santos 2013). The elevation of the Santos project area within the station ranges from 200 to about 260 m asl.

3.2 Land systems

The Northern Works Program areas (Tanumbirini North and Inacumba North) are located at the boundary of the Gulf Falls and Uplands Bioregion and Sturt Bioregions (Figure 3). A detailed investigation of the regional ecosystems has been prepared for the Bullwaddy Conservation Area, situated 33 km to the west and appropriate descriptions have been derived from the Conservation Area Management Plan (NT Parks and Wildlife Commission 2005) and earlier CSIRO investigations of regional Land Systems (Christian *et al.* 1954 and Perry 1960; Perry 1963).

The region is characterised by flat erosional plains dominated by savannah woodlands with mixed eucalypt species, overlying an understory of mixed grasses, with open woodlands on the clay floodplains (NT Parks and Wildlife Commission 2005:5). There are pockets of acacia woodland through this region, including the lancewood (*Acacia shirleyi*) found in the Bullwaddy Conservation Area.

3.3 Geology

The project area contains bedrock formations of Upper Proterozoic, Lower Cambrian, and Lower Cretaceous age, and forms a tableland, which is part of the extensive Barkly-Beetaloo Tableland (Dunn, Smith and Roberts 1962). The low-relief plain is present throughout the project area and

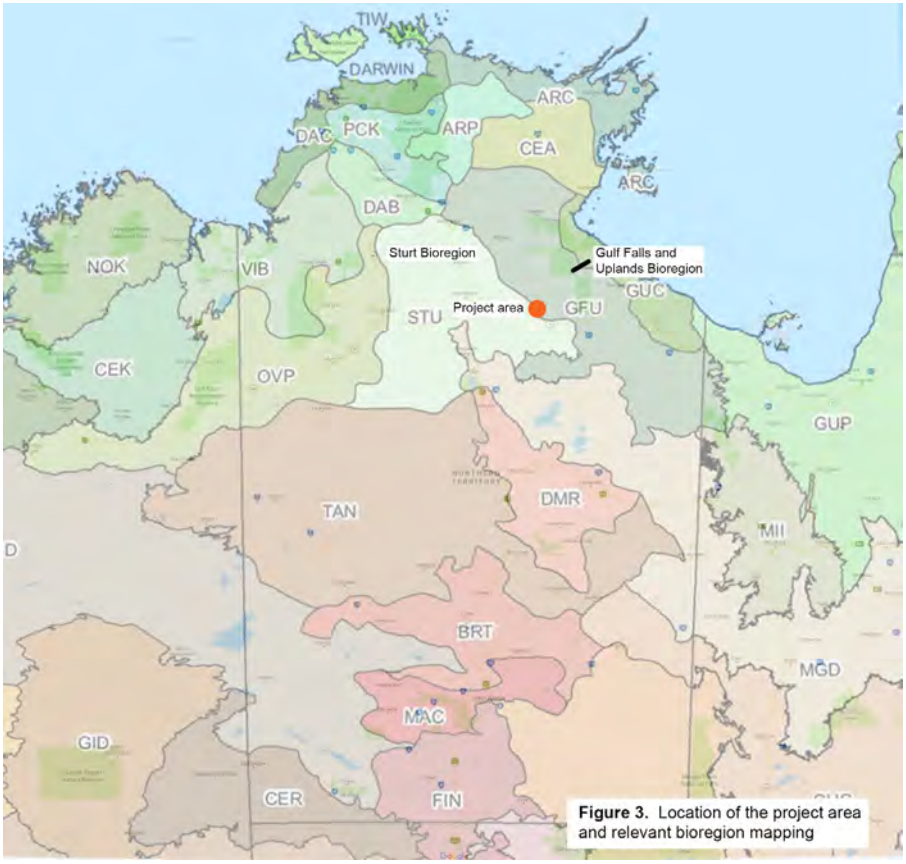


Figure 3. Location of the project area and relevant bioregion mapping

is bounded on the north by a well-defined scarp about 60 m high (Figure 4). The surface of the tableland, which lies between 230 and 274 m asl, is gently undulating and represents parts of an extensive laterite land surface which extends across the entirety of Tanumbirini Station (Paine 1963:3).

The project area is located within the 'Mature Gulf Fall area' (Paine 1963: Fig. 1), where the exposed Upper Proterozoic rocks have altered a drainage system inherited from an early Tertiary laterite surface. Relief in this area is generally 30 to 46 m and locally 76 m. Lower Cretaceous rocks abut the ranges of Upper Proterozoic rocks. Tanumbirini Creek, in the vicinity of the homestead, has been superimposed on Upper Proterozoic rocks, flowing north east across two major sandstone strike ridges of Roper Group rocks (Paine 1963:4).

The Upper Proterozoic rocks up to 5,500 m thick (Paine 1963:12), which outcrop only in the north eastern part of Tanumbirini Station, belong to a sequence laid down in the McArthur Basin, which extended from Arnhem Land to the Queensland border. The sequence is divided into Tawallah, McArthur, and Roper Groups. The Tawallah and Roper Groups are represented in the Tanumbirini Station area (Paine 1963:5).

A small outcrop of altered dolerite/basalt of the Settlement Creek Volcanics overlies glauconitic sandstone of the Rosie Creek Formation at Eight Mile Creek to the northeast of the project area (Paine 1963:5).

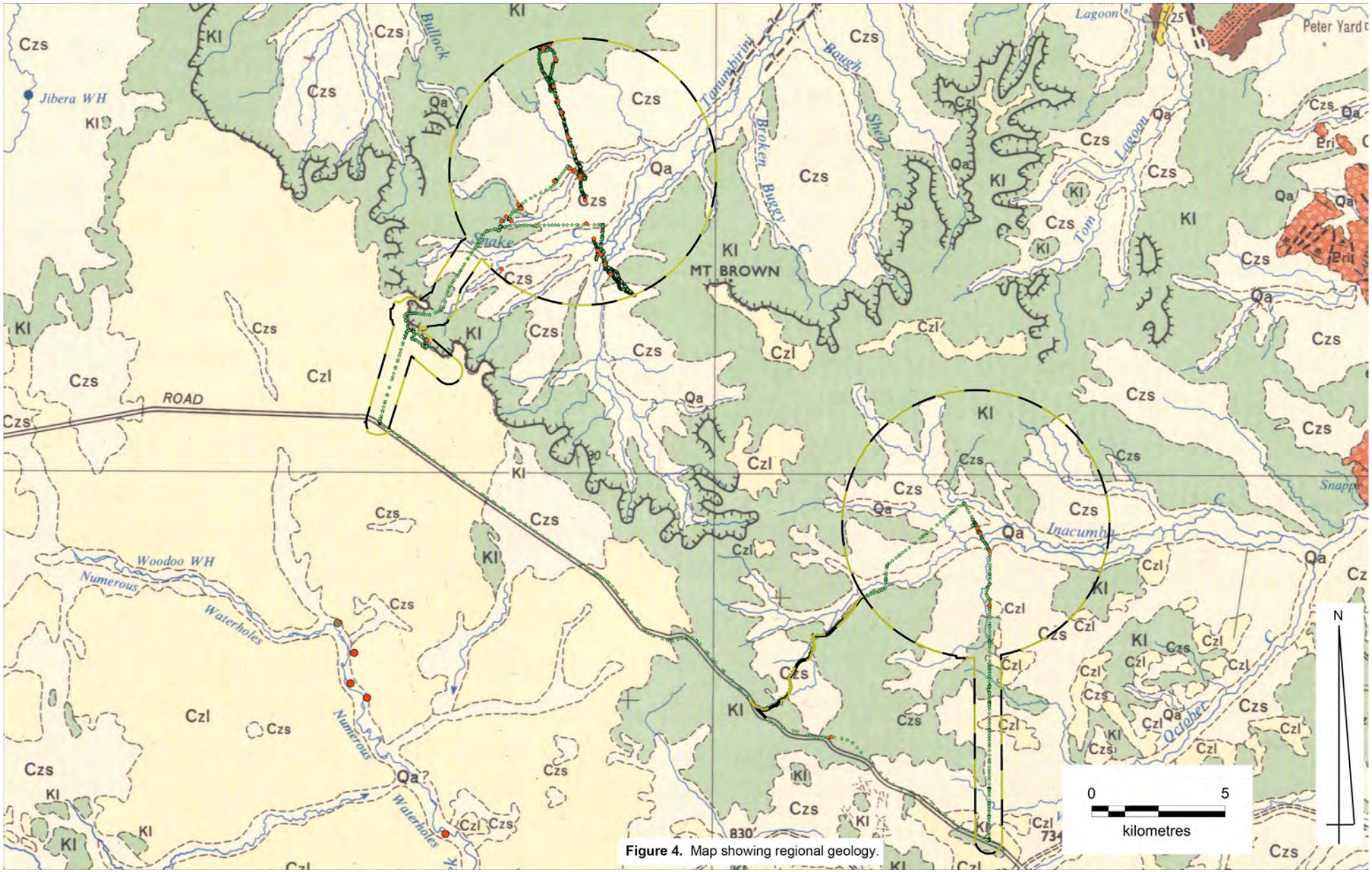


Figure 4. Map showing regional geology.

A layer of unlateritized, partly lithified white leached claystone that exhibits sub-conchoidal fracture outcrops in a road cutting of the Carpentaria Highway in the proposed road modification area at the T-intersection of the Inacumba North Area and also along the southernmost portion of the access track to the Inacumba North Area (see Paine 1963:9).

3.4 Hydrology

A watershed dividing inland from seaward drainage systems extends across the property from northwest to southeast. This watershed is of very low relief and the inland drainage system is poorly developed (Paine 1963: 1). The catchment within the project area drains north-easterly towards the Gulf of Carpentaria.

Watercourses flow at intervals after rain during the wet season but are dry for the remainder of the year. Scattered waterholes may survive the dry season and, other than modern bores with reservoirs, are the only source of water for stock throughout the station during the dry season.

More specificall , water flow in Tanumbirini Creek and Inacumba Creek and in their very minor tributary and overflow drainage lines within the general project area occurs during the wet season, predominantly due to cyclones and monsoonal rainfall. The creeks and their tributary drainage lines are largely ephemeral and usually run dry during the dry season. The flow is of short duration and characterised by high turbidity causing undercutting and creation of creek channel banks especially on bends.

3.5 Vegetation

In general, vegetation types include woodland, open woodland, open forest, tussock grassland and hummock grassland. The dominant species within the vegetation communities present include Darwin stringybark (*Eucalyptus tetrodonta*) and variable-barked bloodwood (*Corymbia dichromophloia*) with a spinifex understorey, and woodland dominated by Kullingal (*Eucalyptus pruinose*) or *Melaleuca* spp. with tussock grass understorey. There are also areas of Lancewood (*Acacia shirleyi*) thicket, Bullwaddy (*Macropteranthes keckwickii*) woodland and Acacia scrub (Santos 2013:5).

Within a radius of ten kilometres of the project area the vegetation types are woodland open forest and tussock grassland. The dominant vegetation type in the immediate area of the Tanumbirini North and Inacumba North project area is woodland, and along the Carpentaria Highway junction for Inacumba North it is woodland and open forest (Santos 2016). The species within the woodland vegetation communities present are dominated by Kullingal and variable barked bloodwood with *Melaleuca* spp. and tussock grass understorey.

3.6 Fauna

Food resources available to Aboriginal people in the past would have been varied and would have included birds, marsupials, reptiles and insects, and plant parts and honey. (see Mulvaney and Kamminga 1999:79-88).

The wider McArthur Basin region supports a diverse range of fauna. Over 435 vertebrate species have been recorded from the Gulf Falls and Uplands bioregion. The sandstone ranges and stony hills of the region support a range of marsupials, reptiles, fish and birds, including a number of endemic species, including Carpentarian Rock Gecko (*Gehyra Borroloola*), Hosmer's Skink (*Egernia hosmeri*) and the Carpentarian Grass-wren (*Amytornis dorotheae*). Major river systems are important environments for many species because of the much lower annual rainfall than the more northern savannas, and the very high summer temperatures.

In the project area itself, the range of plants and animals would have been more restricted, with the dominant fauna being reptiles and when local rainfall permitted, grazing macropods and birds. Spectacled hare-wallabies (*Lagorchestes conspicillatus leichardtii*) find refuge in vine thickets and are common (NT Parks and Wildlife Commission of the Northern Territory 2005:10).

3.7 Climate

The region experiences a 'grassland' climate, based on the Köppen classification system. This classification consists of two distinct seasons: the wet season which lasts from December to March; and the generally dry conditions which last for the remainder of the year (winter drought).

Mean maximum temperature ranges from 29.7°C in June to 38.6°C in November and historically the highest temperatures recorded have been in November. The mean minimum temperature ranges from 12.2°C in July to 24.9°C in December-January. Coolest temperatures occur in June-July. At Daly Waters the average annual rainfall total is 660 mm.

The highly seasonal rainfall and absence of reliable waterholes in the minor creeks that cross the project area may have discouraged sustained occupation of the region by Aboriginal people during the dry season.

3.8 Soils

The landscape of northern and central Australia is ancient and highly weathered. Soil types are susceptible to erosion given that the region experiences long dry periods followed by intense rainfall. In this environment, the soils become disturbed and once disturbed are highly erodible. Termite and other invertebrate bioturbation also reduce and even eliminate the original stratigraphic integrity of biomantle loose sediments.

The project area is characterised by plains and rises associated with deeply weathered soil profiles (laterite) including sand sheets, sandy and earth soils, in particular lateritic yellow earths and brown clays.

In general, the soils in the project area are mostly shallow and gravelly, often overlaying discontinuous layers of detrital ferruginous gravel (commonly termed ironstone), derived from the weathering of haematitic laterite, preserved as iron-rich rock layers in the Sturt Plateau bioregion south of the Carpentaria Highway, along with locally exposed claystone bedrock. This detrital ironstone is ubiquitous and at times extremely abundant on ground surfaces throughout the

project area (see Paine 1963:10).

The soils are Quaternary and Holocene in age and are dominated by kandosols and rudosols. Kandosols are massive and earthy soils (formerly red, yellow and brown earths) that are widespread across the Sturt plateau to the south. More specific lly this soil type is a Ferric brown kandosol that has well-developed B2 horizon in which the major part is massive or has only a weak grade of structure (for descriptive classification see Isbell 1993). Rudosols are very shallow soils or those with minimal soil development and include very shallow gravely soils. In particular, this soil in the project area is a gravelly leptic rudosol originating from lateritic lithosols (Tasker 2017).

Brown demosol also occurs in the project area (Tasker 2017) and these originate from locally occurring lateritic yellow earths/brown clays. This is a clayey soil with a strong blocky structure and no clear or abrupt textural changes between horizons and tends to have a B2 horizon with structure more developed than weak.

Surficial Quaternary alluvium occurs along watercourse corridors and washouts and in other areas of watercourse catchments (Figure 4).

4. Aboriginal history and settlement in the region

4.1 Local Aboriginal organisation

In his historical reconstruction of pre-contact Aboriginal Australia, Tindale (1974) identified the tribal affiliation of the area as *Jingulu*. Tindale defined 'tribal' groups on the basis of written accounts of variable quality; however, many of these records were unreliable. Tindale's tribal boundaries were largely defined according to what he understood to be language groups and his work was conceptualised according to a model of band social organisation in which the clan or 'horde' was considered to be the group which possessed political power and proprietary rights to land.

The assumptions inherent in this conflation of language group with the concept of a 'tribe' are no longer regarded by anthropologists as appropriate. Similarly, the concept of 'tribe' as a territorial group is debatable. In Aboriginal society, people were invariably multilingual rather than monolingual and representing language groups as bounded social groupings is now thought to be inappropriate. In the Radcliffe-Brown model, the land/language relationship was seen as indirect: the estate of a tribe was defined as the aggregation of all the clan estates who shared a common language. This relationship is now viewed to be direct – it is recognised that the importance of land/language relations in Aboriginal society is that particular languages and particular tracts of country were directly linked according to Dreaming events and activity.

While it was previously assumed that tribes or language groups functioned as politically cohesive corporate groups, it is now recognised by anthropologists that linguistic groupings do not structure the Aboriginal social and geographical landscape. Sutton and Rigsby (1979:722) argue that Tindale's tribal boundaries are not meaningful at either a demographic or political level. In order to overcome Tindale's limited and flawed tribal boundary model, recourse must be made to more contemporary anthropological concepts and understanding.

Drawing on accounts of a number of early ethnographers, Wesson (2000) has defined the multi-dimensional aspect of Aboriginal social geography based on habitual place of residence, dominant mode of livelihood, and language. This approach is more meaningful that those underpinning earlier anthropological models.

4.2 Tribal groups in the area

Tanumbirini Station is located within the territory of two language or tribal groups, Jingili and Alawa speakers (Tindale 1974; Sharpe 1969). The Jingili language was spoken by people who inhabited the area including Hodgson Downs, Nutwood Downs, and Tanumbirini stations, south of the Roper River and east of the Stuart Highway (Sharpe 1969).

The Jingulu language is classified as belonging to the Mirndi family of non Pama-Nyungan languages. An early word-list was compiled by F.A. Gillen (Pensalfini 2004:143). Following in the wake of pioneering work by Neil Chadwick in the 1970s, Robert Pensalfini wrote a grammar of Jingulu on the basis of fieldwork with its last known fluent speakers (Pensalfini 1997

According to Jingulu oral tradition, the Jingili originally migrated from the Great Western Desert (Tindale 1974:236). Tindale estimated the size of Jingili territory to be approximately 15,00 km^2, with the southern frontier around Renner Springs extending northwards to Newcastle Waters and also taking in the area of the Ashburton Range. To the east the territory encompassed Cattle Creek south to Wave Hill and Ucharonidge. Their western extension of their territory approached Lake Woods (Tindale 1974:236).

There has been very little academic study of the Alawa language or people (also known as Galawa or Waliburu). The most recent work was a study of the language by Sharpe nearly 50 years ago (Sharpe 1969).

In the early 1960s, Tanumbirini Station was inhabited by a single station manager and several Aboriginal people who lived and worked on the station with a number of their family members. The language or tribal affiliation of these residents was not reported.

5. Nature of the proposed work activities

There are a number of activities proposed as part of Santos Northern Works Program in EP161. The locations where the impacts will occur are shown in Figure 6. Proposed activities will include a 2D seismic survey along a 10 km transect through the Tanumbirini North area. There will be additional activities associated with this seismic survey program including upgrading of access tracks to facilitate the entry and egress of vehicles.

Impacts from the seismic survey will be minimal. It will be necessary for vehicle access along the 10 km line, which may require some clearing of uneven ground and to allow crossing of minor watercourses. The line will then be prepared and geophone arrays laid by hand with access provided by four wheel drive vehicles. Once the geophone lines have been laid, the seismic

survey will be conducted using vibroseis trucks shod with pneumatic tyres. The impacts from this activity will be localised and shallow and will mainly arise when access for the seismic line is prepared. Once the seismic survey program has been completed the vehicle tracks should, over time, revert to their pre-survey state.

The second area where works are planned is situated 15 km further to the east, in the Inacumba North area. Here a pilot well is to be drilled, requiring impacts within an area of approximately 200 m of the hole centre to accommodate drilling infrastructure, in addition to upgrades to access tracks and modifications of access onto the Carpentaria Highway, to permit safe entry and egress for trucks.

Construction activities for the well will require ground works that will include:

- Site preparation for a well pad,
- New access roads and upgraded access roads,
- Site preparation for a temporary camp including temporary sewerage treatment plant,
- Site preparation of laydown areas,
- Construction of borrow pits,
- Construction and equipping of water bores,
- Dedicated area for equipment storage,
- Installation of temporary fencing, gates and motor grids.

6. Aboriginal cultural heritage assessment methodology

Ideally, there are five major steps that are required in archaeological heritage assessment.

Step 1 – Register search

A search of relevant heritage registers and databases is undertaken to:

- ascertain if any known Aboriginal or non-Aboriginal heritage sites/relics occur within or in close proximity to the project area;
- provide data to assist in predicting the types and frequency of Aboriginal and non-Aboriginal sites/relics that may occur in the development area, within the local area or region generally.

Step 2 – Assessment of landscape features and sediments

The second stage of the assessment process requires the examination of the landscape setting and environment of the project area. These include an understanding of the surface geology, geomorphology and sediments, which may have affected past land-use practices, survival of sites in the landscape and the detectability of sites. This assessment also includes noting of tree varieties and tree ages to assist in identifying culturally modified trees. In particular, certain landscape features have a higher potential to contain Aboriginal relics.

Step 3 – Desktop assessment and visual inspection

An archaeologist identifies landscape features with the potential to contain sites and undisturbed relics. Relevant archaeological research reports for sites within the project area and for the

area or region generally, as appropriate, are examined to provide baseline data and a broader understanding of the cultural heritage context of the area subject to potential impact.
A field assessment entails a pedestrian archaeological survey of the subject land, with particular attention to archaeologically sensitive landscape features such as watercourses, rocky escarpments, areas of exposure, and pavements with exposed gravel on which stone artefact scatters are readily detectable.

Step 4 – Reporting results
Reporting of the findings and recommendations from the assessment. A written report documenting the procedures, results and recommendations of the archaeological heritage assessment is produced to support the conclusions.

Step 5 – Further investigation and impact assessment (if required)
After assessing the significance of the archaeological site/relic, recommendations are made regarding compliance with the provisions of the Northern Territory *Heritage Act,* 2011.

The specific aims of this archaeological assessment were to:

1. Identify known Aboriginal and non-Aboriginal archaeological heritage sites and/or relics within the subject land area and assess the area for its potential to contain unidentified sites/ objects.

2. Identify any potential archaeological heritage constraints and formulate recommendations and management strategies and options with regard to the proposed activity/development.

3. Provide an assessment as to whether or not further archaeological heritage investigation or assessment is required prior to the commencement of the proposed development.

4. Determine whether further detailed investigations may be needed to be undertaken to meet statutory requirements.

7. Results of the background research and the Site Register searches

Searches of the NT Heritage Register, Aboriginal Areas Protection Authority (AAPA) database, and NT Archaeological Sites Database were undertaken on 4 March 2019. (Table 1, and Figure 5).

Other documents reviewed included the relevant work program issued to Northern Lands Council (NLC), an update to that work program, geospatial data and maps of the project area derived from the database searches, archaeological, historical and anthropological literature, and scientific literature relating to environment and geology.

Archaeological research over the past five decades has shown that Aboriginal people have occupied Australia for at least 40,000+ years (Mulvaney and Kamminga 1999:2). By 35,000 years

Site_Name	Zone	East GDA94	North GDA94	Site_Type	Contents
Broadmere St. 1				rock art	paintings
Balbirini Creek 6	53			Stone artefact scatter, grindstone portable	artefact scatter
Balbirini Creek1	53			Stone artefact scatter	artefact scatter
Balbirini Creek2	53			Stone artefact scatter	artefact scatter
Balbirini Creek3	53			Stone artefact scatter	knapping floo
Balbirini Creek4	53			quarry	quarry
Balbirini Creek5	53			Stone artefact scatter, grindstone portable	artefact scatter
Bauhinia Downs1	53			Stone artefact scatter	artefact scatter
Binda	53			Rock art, Restricted anthropological site, ceremonial ground	petroglyph
Broadmere St. 10	53			Stone artefact scatter	artefact scatter
Broadmere St. 11	53			rock art	paintings
Broadmere St. 3	53			Stone artefact scatter, midden	artefact scatter, midden
Broadmere St. 4	53			Stone artefact scatter, quarry	artefact scatter, quarry
Broadmere St. 5	53			Stone artefact scatter	artefact scatter
Broadmere St. 7	53			Stone artefact scatter, midden	artefact scatter, midden
Broadmere St. 8	53			rock art	paintings
Broadmere St. 9	53			rock art	paintings
Carpenteria Hwy 1	53			Stone artefact scatter, grindstone portable	artefact scatter
Eleanor Pool Yard1	53			stone artefact scatter, historic site, stone arrangement, grindstone portable	artefact scatter, stone arrangement , faunal remains
Favenc Site (Telecom)	53			Stone artefact scatter	artefact scatter
Goanna Site (Telecom) [Pipeline Site B - Mitchell: not located]	53			Stone artefact scatter	artefact scatter
Lansen Springs (Broadmere St. 6)	53			Stone artefact scatter	artefact scatter
Newcastle Creek 1	53			Isolated stone artefact	stone artefact
Newcastle Creek 2	53			Stone artefact scatter	artefact scatter
Newcastle Creek 3	53			Stone artefact scatter	artefact scatter
Newcastle Creek 4	53			Stone artefact scatter	artefact scatter
Newcastle Creek 5	53			Stone artefact scatter	artefact scatter
Old Tanumbirini Station	53			Skeletal remains, stone arrangement	skeletal remains, stone arrangement
OT Down2	53			Stone artefact scatter	artefact scatter
OT Down3	53			Stone artefact scatter, grindstone portable	artefact scatter
OT Downs1	53			quarry	quarry

Table 1. List of sites recorded on the Northern Territory Heritage Register for the region around the project area. Old AGD66 coordinates have been converted into GDA94 format.

Pipeline Site A - Goanna Creek 2	53			rockshelter deposit, rock art, stone artefact scatter, shell scatter, grindstone portable	artefact scatter, paintings, midden
Pipeline Site C - Little Creek 2	53			Stone artefact scatter	artefact scatter
Urrwalala [DML - 1975, MH - 1986]	53			Stone artefact scatter, shell midden, rock art, grinding place non-portable	artefact scatter, midden, paintings, grinding hollows / grooves
Yaroo 1	53			Stone artefact scatter	artefact scatter
Yaroo 2	53			Stone artefact scatter	artefact scatter
McArthur River 2D Seismic Site 1	53			Stone artefact scatter, hearths, camp sites, knapping floor	Stone artefact scatter

Table 1. List of sites recorded on the Northern Territory Heritage Register for the region around the project area. Old AGD66 coordinates have been converted into GDA94 format.

ago all major environmental zones in Australia, including semi-desert and desert country and even periglacial environments of Tasmania, were occupied (Mulvaney and Kamminga 1999:114).

At the time of early Aboriginal occupation, Australia experienced moderate temperatures. At the commencement of the Last Glacial Maximum (LGM) at about 24-22,000 years ago, sea levels fell to about 130 m below present levels and accordingly, the continent was correspondingly larger. However, between 24,000 and 12,000 years ago (at the height of the Last Glacial Maximum) dry and either intensely hot or cold temperatures prevailed over the continent.

With the amelioration of glacial conditions, temperatures rose with a concomitant rise in sea levels. By ca. 6000 BP sea levels had more or less stabilised at their current position (but now again rising slowly). With the changes in climate during the Holocene, Aboriginal inhabitants had to deal not only with reduced landmass but with changing hydrological systems and vegetation; forests and woodlands again spread across the grasslands and shrublands of the Late Glacial Maximum.

Human occupation of the study area must have been very sparse throughout prehistory into modern times, especially so for earlier millennia. The area was environmentally challenging, only becoming more habitable during the later Holocene period.

Only one major archaeological consultancy report is available for the wider region generally (Guse and Collis 1998). This survey and assessment report was prepared for North Australian Basins Resource Evaluations, AGSO. The study was along a proposed 70+ km 2D seismic line in the McArthur River Region, well to the east of the project area. The topographic, geological and environmental contexts do not correspond sufficiently to those of the current archaeological survey areas to provide more than the most general information. For instance, there are rock shelters habitation sites, rock art sites and rock shelters with burials in the MacArthur River region. The land systems in which these sites occur are not present in the vicinity of the current survey

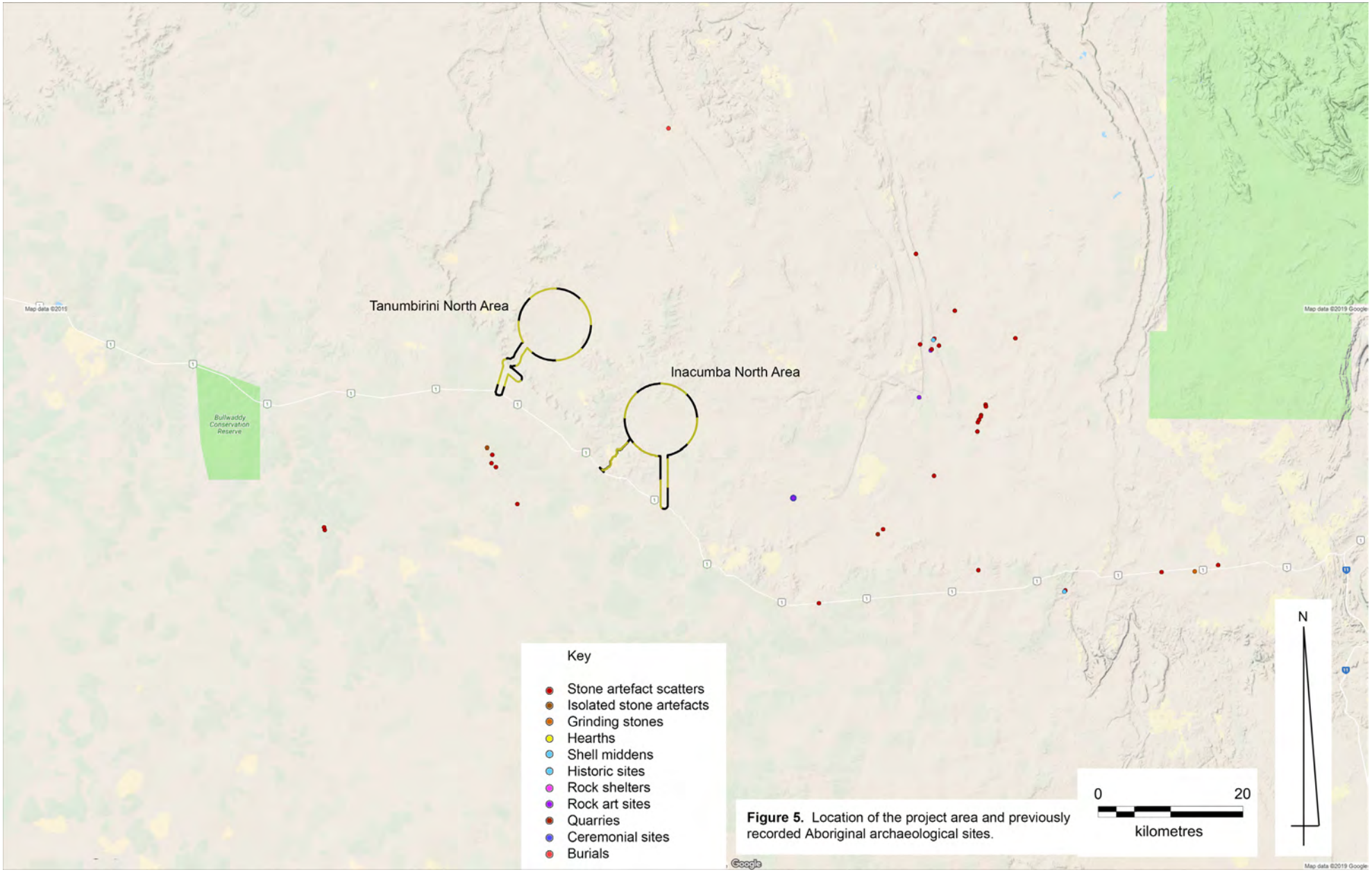


Figure 5. Location of the project area and previously recorded Aboriginal archaeological sites.

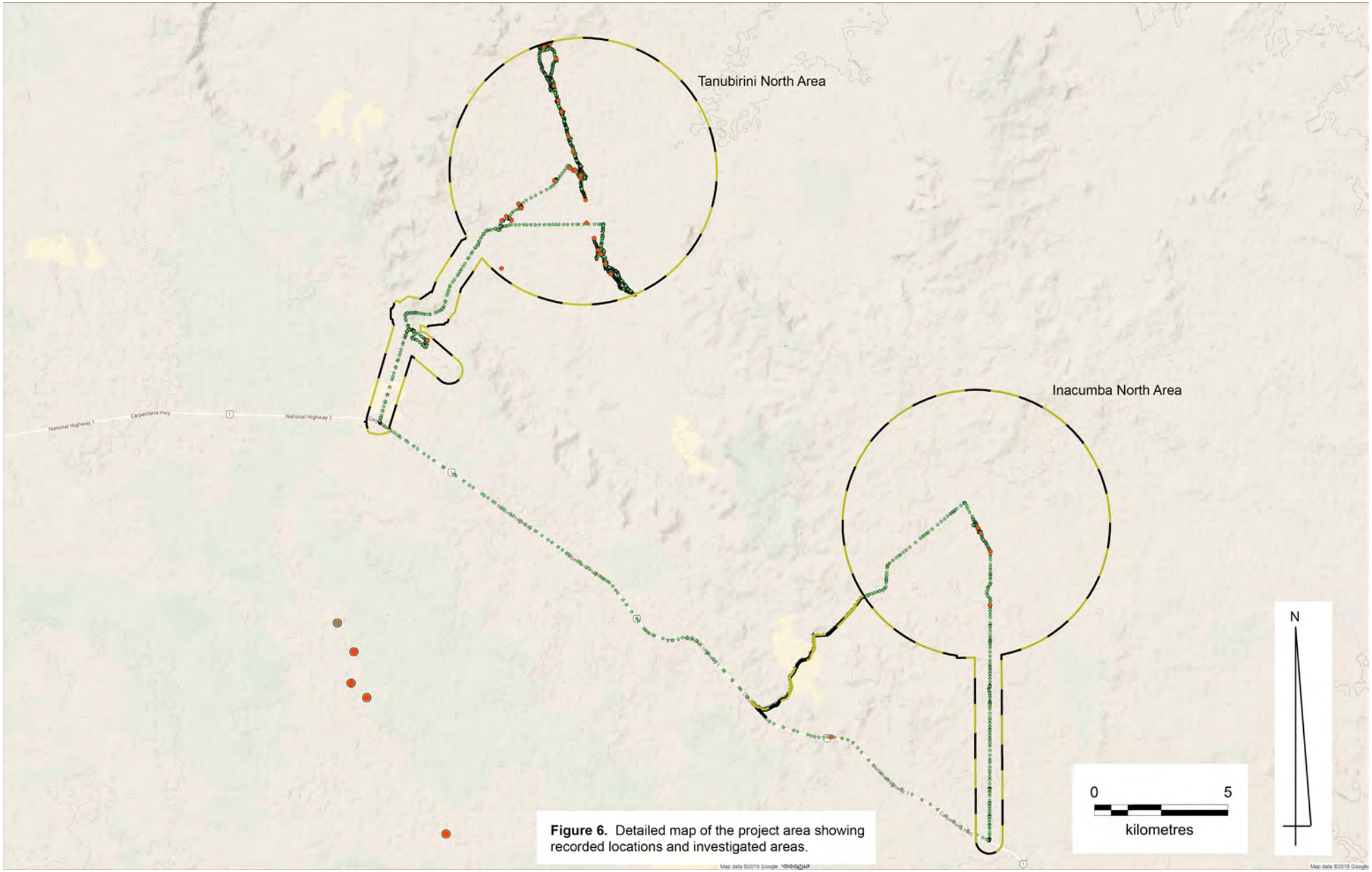


Figure 6. Detailed map of the project area showing recorded locations and investigated areas.

areas because of an absence of bedrock suitable for shelter or cave development.

Closer to the project area, small archaeological surveys have been undertaken in previous decades for various developments such as telecommunications infrastructure. Within this more proximal general area but still well beyond the current archaeological survey areas, stone artefact scatters (mostly flaking débitage) are the predominant site type, followed by a single hearth and skeletal remains, two stone arrangements, three shell middens, six rock art sites and two postulated 'quarry' sites.

The closest archaeological sites are approximately seven kilometres south of the Carpentaria Highway, and at least 15 km from the nearest significant construction or seismic survey impacts. This cluster of four stone artefact scatters and one isolated stone artefact are found beside waterholes in Newcastle Creek, a southward flowing stream. A rock art site is found approximately 16 km southeast of the Inacumba North Area. This site is found in a rocky escarpment near the headwaters of Parsons Creek. Further sites (quarries, stone artefact scatters and hearths) are found in the escarpments to the east of these sites and more than 30 km from the project area.

7.1 Historical places

A search of the NT Heritage Register has indicated that there are no listed heritage items or places in the vicinity of the project footprint. (Santos 2018:53). Only two declared historical places have been registered in the region NRETAS (2010). Both of these places are south of the village of Elliot and more than 150 km from the project area (NRETAS 2010).

Ucharonidge Station is located 19 kilometres south of Elliott and 77 kilometres east on the Barkly Stock Route on the Barkly Tableland. Powell Creek Overland Telegraph Station, south of the village of Elliott and over 170 km distant from the proposed project area. This site was listed on the Register of the National Estate and declared a Heritage Place under provision of the *Heritage Act*. The station was established in 1872 and is one of 11 repeater stations built along the Overland Telegraph Line.

8. Predictive modelling of the nature of Aboriginal sites/relics

8.1 Degree of preservation Aboriginal material culture

Items of organic material culture, such as wooden spears, digging sticks and small bags and nets will not have been preserved in the moderately acidic open-air sediments found in the project area.

However, various stone artefacts are likely to occur in the general region and will be preserved indefinitely

- Macroblades (Mulvaney and Kamminga 1999:Map 12)
- Hatchet heads
- Unifiacial and bifacial points (Mulvaney and Kamminga 1999:Map 12c
- Unretouched and retouched flakes used for light-duty cuttin

- A number of other flaked stone tool typ
- knapping debitage
- grinding stones

Stone quarry

Background research has indicated no likelihood for the occurrence of geological sources of stone suitable for Aboriginal stone tool making, hence stone quarries are highly unlikely to occur within or in the vicinity of the project area. There are recorded quarries distant from the project area in geologically complex areas near the McArthur River.

Culturally modified tree (scarred tree)

Culturally scarred old-growth trees may occur in the general area but generally will be difficult to identify with confidence (see scarred tree discussion in Appendix 2).

Aboriginal ancestral remains

Generally, Aboriginal people were buried in unconsolidated sandy sediment such as sand bodies along watercourses or in sand dunes occurring in other environmental contexts. The presence of human burials of relatively recent age within or in the general vicinity of the project area cannot be completely excluded. However, there is no evidence for the occurrence of strongly alkaline sediment that would be conducive to bone preservation. The pH readings of the surficial sediment taken at different locations in the project area were consistently 6.8, indicating slightly acidic conditions. Given the prevailing climatic conditions, in particular the high wet season rainfall, and the lack of ground-surface sheltering, and the physical and chemical character of the sediments, the preservation of bone remains is unlikely.

8.2 Incidence and size of stone artefact scatters and stratified sites

As well as the issue of stone availability, low human population density in prehistoric times equates to relatively low discard rate of stone artefacts such as flaking debris which typically marks the location of a former camping area.

A corollary of low population density in the study area is that a small number of spatially restricted base camps is the most likely prehistoric settlement pattern, along with small more transitory habitation sites. Both large and small camping areas would tend to be very close to water sources, especially during the dry season. The presence of the cluster of stone artefact scatter sites beside waterholes on the southern side of the Carpentaria Highway is evidence of such a settlement pattern.

Aboriginal hearths or remnants of hearths may be preserved in sandy sediment. Such hearths usually contain pieces of termite mound (e.g. Basedow 1907), or locally available stone.

Given the general environmental context, Aboriginal camping areas, and in particular ‘base camps’ occupied for more extended periods, would have been focussed on more permanent water sources such as watercourse channels, and waterholes during the dry season. Repeated

occupation of favoured camping areas normally resulted in repeated discard of stone artefacts in areas where stone suitable for making stone tools occurs locally. The vast majority of preserved stone artefacts at camp sites are pieces, often quite small pieces, of stone waste ('débitage') created during the making and resharpening of stone tools, rather than the tools themselves.

Appendix 2 provides descriptions of the types of Aboriginal sites that have previously been recorded in this region.

The review of available data, particularly the sites recorded during earlier studies throughout this region, indicated that the range of Aboriginal cultural heritage sites more likely to be preserved within the project area includes:

1. Isolated stone artefacts.
2. Aboriginal hearths (earth ovens).
3. Stone artefact scatters. (sometimes associated with Potential Archaeological Deposits (PADs) comprising subsurface artefacts and other objects or features).
4. Scarred trees.

The background data review indicates that:

There appear to be no local sources of stone for stone tool making. All stone, other than ironstone for red and yellow pigment, would have had to be brought into the project area; possibly well beyond daily hunting and foraging distance from the encampment area. The potential distances of suitable stone sources are not known at this time, other than that sandstone possibly suitable for grinding stones and abraders; brittle siliceous stone with conchoidal fracture properties, and tough volcanic or metamorphic stone for ground stone tools, are likely to occur within the general area. The quarry sites previously recorded to the east of the project area are found in areas of siltstone and sandstone, not usually associated with quarries, except as quarries used for the projection of grinding stones.

In areas where more effort was needed to acquire stone by direct travel or through trade, it would have had increased value as a necessary material or commodity. This means that the stone tools used in the area are much more likely to have brought on site in a prepared state (rather than as unmodifie or partially modified cores), hence there will be very little stone knapping débitage in campsites. Also, the stone tools were curated for longer to get the most use-life from them, making it most likely that those stone tools that are found will be small and highly reduced.

This general maxim indicates that suitable stone close at hand is more likely to have be knapped and the knapping débitage discarded in relative abundance in the areas around the sources of stone. There will be no large workshop sites in areas distant from the stone sources.

On the basis of the background environmental (particularly hydrological) and geological data it is concluded that only a small number of spatially-restricted base camps are likely to have existed

and be detectable in this region. Such sites are unlikely to occur within the project area, but rather near waterholes in more substantial creeks. Preferred camping areas would have been located very close to the more reliable water sources, especially those used during the dry season.

Within the project area in general, the human population density would have been low overall, and consequently low discard rates of stone artefacts such as flaking debris and of grinding stones will have led to small, low-density and hence low-visibility sites.

9. Field survey methodology

An archaeological field survey was carried out within and around areas potentially subject to impact from work activities associated with the proposed exploration and drilling activities on Tanumbirini Station. This archaeological survey was undertaken by Principal Archaeologist Dr Johan Kamminga over a three-day period (6-8 March 2019). Mr. Trevor Edwards (Projects Specialist, Land Access & Management Services Pty Ltd) assisted in liaising with station staff and as guide and informant.

One main focus of the survey was the 10 km route of a proposed seismic line. This provided a transect across the Tanumbirini North Area from northwest to southeast, crossing all of the main land units present in the project area: Quaternary sediments, undifferentiated Cainozoic laterites, lateritic rubble and soil, and more resistant areas of Cretaceous lateritised claystone, soft grey claystone, sandstone and conglomerate (Figure 4).

Detailed inspection of areas along the seismic line allowed a comprehensive search for traces of prior Aboriginal visitation. These pedestrian surveys were conducted giving a coverage of approximately 5 m wide and perpendicular to the seismic survey line. Areas with relatively high ground surface visibility were selected as these offered the greatest possibility for the detection of small stone artefacts. Erosional scours were uncommon through this area. Generally, the recorded survey paths were sampled approximately between 100 and 200 m. Vehicle traverses were also carried out at a speed of approximately 5 km/hr. The vehicle traverses suited observation of the ground surface along tracks and road verges and also large expanses of flood overflow areas with exceptional ground surface visibility, generally around 100%.

Along survey routes and in other selected areas, mature trees were examined for evidence of cultural scarring. Tracks and sample locations were recorded using a hand-held GPS receiver, accurate to within 5 m. A low-magnification Wild M5 stereomicroscope was used to examine stone samples during the field survey (Plate 1).

In addition to the seismic survey line transect, areas along access tracks and a transect across the eastern portion of the Inacumba North Area were also inspected. The landscape setting of this area was similar to that found in the Tanumbirini North Area, with laterite gravel over much of the land surface. A number of sample areas were selected here and a detailed search for traces of prior Aboriginal visitation was undertaken. The environmental and landscape conditions of each

sample area were recorded.

10. Results of the archaeological field survey

The nature and distribution of Aboriginal site types recorded on the registers and databases was reviewed during background research for this study. In reference to the environmental, geological and topographic contexts of the local and wider area, the types and distributions of sites/relics was predictable. As discussed below, the field survey has revealed no evidence for the presence of Aboriginal or non-Aboriginal archaeological sites/relics of any kind.

Ground surface visibility (GSV) within areas examined closely was generally good to very good (commonly 50-100% GSV).

The field survey corroborates the background research finding that there appear to be no local sources of stone for stone-tool making. All stone, other than ironstone for red and yellow pigment, would have had to be brought in to the area; possibly from well beyond daily hunting and foraging distances from the encampment area. The potential distances of suitable stone sources are not known at this time, other than that sandstone possibly suitable for grinding stones and abraders, and brittle siliceous stone with conchoidal fracture properties (located approximately 30 km to the east), and also volcanic or metamorphic stone for ground-stone tools, may occur within the general region.

In areas where a greater effort was needed to acquire stone by direct travel or by barter, that stone would have had increased value as a necessary material or commodity. This means that the stone tools used in the area are much more likely to have been pre-knapped, hence very little

Plate 1. Low-magnifi ation microscopic examination of natural stone occurring in a creek bank in the Tanumbirini North Area.

Plate 2. Area of clear ground surface visibility within a washout adjacent to a small watercourse in the Tanumbirini North Area.

Plate 3. Area of exposed ground at the Tanumbirini 1 well.

Plate 4. Meandering steep outer side of bend in a creek channel where ironstone lag has been concentrated on the more gently inclined inside slope of the channel. No Aboriginal stone artefacts were found in this location, despite the clear ground surface visibility on the ironstone gravel pavement.

Plate 5. Ironstone gravel lag pavement in a washout in the Ianumbirini North Area.

Plate 6. Actively migrating creek channel, exhibiting erosion causing tree fall and a steep outer channel margin exposing depth of loose clayey sand sediment. Located in the Tanumbirini North Area. Aboriginal stone artefacts are absent in the section along the channel bank or within the channel.

Plate 7. Termite mounds in the Ianumbirini North Area. Termite mounds are ubiquitous throughout this region.

Plate 8. Dense pavement of rain-washed ironstone gravel adjacent to the Tanumbirini 1 Well.

stone knapping débitage would be found in the camps. Also, the stone tools would have been curated for longer to get the most use-life from them, making them fewer and smaller.

The rule more or less means that high stone artefact densities and larger sites are more common in areas with abundant raw materials, while in areas with sparse or distant raw material soures, these sites tend to be smaller, with more heavily curated and smaller tools.

It was noted that almost all of the project area would not have been suitable for sustained or repeated encampment during prehistoric times. The watercourses in the area were mostly ephemeral first-order streams flowing northeast and they tended to be dry for extended periods

The surficial soil layer over much of the project area appears to be shallow to very shallow, though less so along watercourses.

Termite mounds and ant nests (Plate 7.) are ubiquitous throughout much of the survey area, indicating that intensive invertebrate bioturbation of the loose sediment of the biomantle has been occurring over thousands of years up to the present time (c.f. Cahen & Moeyerson 1977; Dean-Jones & Mitchell 1993:43, 46; Mitchell 1988:52; Moeyersons 1978; O'Connell *et al.* 2018). As a consequence of this ongoing low-intensity long-term invertebrate bioturbation, many or most Aboriginal artefacts are not likely to be in their original stratigraphic context (cf., O'Connell *et al.*

2018).

11. Conclusions

No World Heritage Properties or National Heritage Places are registered within 10 km of the project area (see also Santos 2018:39). In addition, a search of the Northern Territory Heritage Register (DTC 2018) for NT Portion 701 (on which the Tanumbirini project area is located) was conducted and no previously recorded Aboriginal heritage items or places have been found in the project area (Santos 2018:39).

During the archaeological field survey, no Aboriginal or non-Aboriginal sites/relics were identified in the project area. It is considered that the survey coverage provides a good indication of the distribution of habitation sites through the areas likely to be affected by exploration and construction activities. The field survey has revealed that if there are traces of Aboriginal habitation in the project area, they occur at very low densities and/or are very localised. If this is the case, as we would argue, it is considered very unlikely that Aboriginal and non-Indigenous sites and relics would be disturbed or otherwise affected by the work associated with the proposed activities in the Northern Locations of the Santos McArthur Basin work program.

12. General recommendations

In general, ground surface visibility was relatively high in the areas examined. It is notable that no Aboriginal or non-Aboriginal sites/relics were identified during the survey. It is recommended that no further archaeological survey is required, unless Aboriginal or non-Aboriginal sites/relics are uncovered during proposed works activities.

While there were no traces of prior Aboriginal habitation detected during the field assessment, it is necessary to proceed with due care when undertaking works in the project area. In particular, any Aboriginal site/relic identified during the activity must be reported to the Santos Cultural Heritage Team so appropriate protection measures can be implemented.

It is advisable that a cultural heritage awareness program is provided to all those involved in ground disturbance activities to ensure that should Aboriginal sites and relics be uncovered during earthworks, that workers are trained to recognise the likely cultural heritage items and be aware of their responsibilities for reporting all exposed sites and relics.

If any human skeletal remains are encountered, work must stop immediately, the area secured to prevent unauthorised access, and the Northern Territory police contacted.

13. References

Basedow, Herbert 1907. Anthropological notes on the western coastal tribes of the Northern Territory of South Australia, *Transactions of the Royal Society of South Australia*, 31:1-64.

Guse D. and A. Collis 1998. Archaeological survey of proposed NABRE seismic lines, McArthur River Region, NT. A report for the North Australian Basins Resource Evaluation. Australian Geological Survey Organisation. Quaternary Archaeological Surveys, Casuarina, NT.

Isbell, R.F. 1993. *A Classification System for Australian Soils (Third Approximation)*. CSIRO Division of Soils Technical Report 2.

Kamminga, Johan 1979. The nature of polish on prehistoric stone tools; and 'Commentary on tool design and microscopic residues'. In *Lithic use-wear analysis*. Brian Hayden (ed.), Academic Press, New York, pp. 143-57.

Kamminga, Johan & Allan Lance 2016. Vickery Extension Project – Scarred tree assessment. Report to Whitehaven Coal Limited. Heritage Consulting Australia Pty Ltd. May 2016.

Mulvaney, John and Johan Kamminga 1999. *Prehistory of Australia*. Allen & Unwin, Sydney.

NT Parks and Wildlife Commission 2005 *Bullwaddy Conservation Reserve Plan of Management*. Parks and Wildlife Commission of the Northern Territory, Katherine.

NRETAS (2010). *Ucharonidge Station Number 1 Bore and 1949 Comet Windmill: Background Historical Information*. Heritage Branch, NT Department of Natural Resources, Environment, the Arts and Sport, Darwin.

Paine, A.G.L. 1963 Tanumbirini N.T. 1:250 000 Geological Series, Explanatory Notes. Bureau of Mineral Resources, Geology and Geophysics, Canberra.

Pensalfini, Rob 2004. Eulogizing a language: the Ngarnka experience. *International Journal of the Sociology of Language*, 164:141–156.

Pensalfini, Robert J. 1997. *Jingulu grammar, dictionary, and texts*. Massachusetts Institute of Technology.

Sharpe, Margaret 1969. Alawa phonology and grammar. PhD Thesis, School of English, Media Studies and Art History, The University of Queensland.

Santos 2013. Exploration Permit 161– Tanumbirini 1 exploration well environment plan summary. ENV-EP161 TAN 0003. Report to N.T. Department of Mines and Energy, Darwin.

Santos 2016. Exploration Permit (EP)-161 2016 Stratigraphic Corehole Program. Environment Plan Summary.

Santos 2018. NT Exploration Permit 161. Tanumbirini North Water Bore Monitoring Program.

Environnent Management Plan. Document No: MAB-PLN-005.
https://dpir.nt.gov.au/__data/assets/pdf_file/0005/370589/ep161-marmbulligan-envir nment-plan-summary.pdf

Sutton, Peter and Bruce Rigsby 1979. Linguistic communities and social networks on Cape York Peninsula. In S. Wurm (Ed.) *Australian linguistic studies*. *Pacific Linguistics*. Canberra, pp. 713-732.

Tasker, M.C. 2017. Application to clear pastoral land (s.38(1)(h) Pastoral Land Act). Application to the Pastoral Land Board Northern Territory, Darwin, by manager of Tanumbirini Station.

Tindale, Norman B. 1974. *Aboriginal Tribes of Australia: their terrain, environmental controls, distribution, limits, and proper names.* University of California Press, Berkeley.

Tindale, N.B. 1974. «Kotandji (NT)». *Aboriginal Tribes of Australia: Their Terrain, Environmental Controls, Distribution, Limits, and Proper Names*. Australian National University, Canberra.

Wood, B., D. Siverisen and C. Olsen 1981 *Land Systems of the Upper McArthur River Catchment*. Conservation Commission of the Northern Territory, Darwin.

Appendix 1 - Glossary of technical terms

AAPA

The Aboriginal Areas Protection Authority (AAPA) is an independent statutory authority established under the *Northern Territory Aboriginal Sacred Sites Act*. The Authority is responsible for overseeing the protection of Aboriginal sacred sites on land and sea across Australia's Northern Territory.

Background scatter

Generally, a very low density, more or less continuous distribution of artefacts over the land surface. Although these artefacts do not constitute a 'site' they are given location details for research purposes and to fulfil legislative requirements

Bifacial point

Flakes or blades retouched along both ventral and dorsal surfaces of a flake to enhance or give the artefact its pointed shape. They often have the flake s initiation surface (striking platform) platform removed by retouch and this proximal end of the point rounded.

Grinding stone

Top and bottom grindstones, pestles and mortars characterised by at least one use-work and abraded surface.

Hammerstone

A stone that have use-wear on the surface in the form of abrasion and pitting characteristic of hammer usage.

Hatchet head (Edge ground hatchet head)

have been shaped by the process of flaking, pecking and grinding (polishing). They generally have only one cutting edge that has been ground to a straight or moderately convex plan shape.

Knapping (of stone)

Flaking stone to make stone implements. This is done by striking a piece of stone with a stone hammer (dynamic load in freehand percussion), or by more delicately applying pressure with a small stone or a piece of wood or bone.

Lag

A lag deposit is the deposition of stones winnowed by physical action. Fluvial processes (as occurs in the Santos project area), aeolian processes, and tidal processes can remove the finer portion of a sedimentary deposit leaving the coarser stones behind.

Manuport

A stone or fragment of stone that does not occur naturally in an area and must have been carried in by humans. Natural occurrences of locally-exotic stones include emu gastroliths and Permian

age ice-rafted ‘dropstones’.

NLC
Northern Land Council.

Northern Territory Archaeological Site Database
A database of sites recorded in the Northern Territory including location and description details. Sites are protected by Northern Territory *Heritage Act, 2011*.

Sacred Site
Areas of significance for sacred sites is considered through the process of securing a sacred site clearance certificate (SSCC) from the Northern Land Council (NLC) and an Authority Certificate from the Aboriginal Areas Protection Authority (AAPA). This process aims to prevent damage to, and interference with sacred sites, by identifying and setting out the conditions for entering and working on the land.

Site
An archaeological site is defined for this survey as having more than one archaeological object within am area of two square metres, or a concentration of artefacts with an average density five times greater than the average density of the background scatter. A site will have an identifiable boundary where either artefact densities decrease to the extent as to be classified as background scatter or environmental features determine the boundary.

Siliceous stone
Rock or stone that is predominantly comprised of silica, usually in the form of quartz crypto-, micro- or macro-crystals. Examples are vein and macro-crystal quartz, quartzite, sandstone, silcrete, chert and chalcedony. These are the stone types commonly used by Aborigine people for making into stone tools.

Stone artefact scatter
An area of stone artefacts scattered on the ground, usually within an area of ground surface erosion. These artefacts are very predominantly the debris from knapping stone to make stone tools. Not uncommonly the scatter is associated with stone artefacts that occur below ground surface, unless scattered across a bare rock surface.

Subject land
The land area that is the subject of proposed work activities or development.

Transect (survey transect)
A straight line or narrow section through an object or natural feature or across the earth’s surface, along which observations are made or measurements taken.

Unifacial point

Flakes or blades that have been retouched along the margins from one surface, either ventral or dorsal to give or enhance its pointed shape. They can be symmetrical or leaf shaped.

Appendix 2 – Aboriginal site types likely to occur in this region

Probably more than 200 million people have lived on the Australian continent since it was first settled more than 40,000 years ago. The material evidence of this human presence and activity is abundant and widespread. Because stone is a highly durable material, stone artefacts are found widely distributed across the continent and sometimes are highly concentrated in certain land units, and in particular areas within these land units.

An Aboriginal archaeological site is defined as any material evidence of past Aboriginal activity in a context or place where the activity occurred (Officer and Navin 1998). Thus, significant Aboriginal sites or places such as 'Dreaming or Story site' do not necessarily have associated cultural remains. However, the vast majority of Aboriginal sites are open-air camps, indicated only by stone flaking debris and discarded stone implements, or sometimes an intact hearth with burnt remains.

The range of Australian Aboriginal sites likely to occur in the subject area can be categorised as:

1. Isolated artefact (usually stone).
2. Isolated hearth.
3. Stone artefact scatter (sometimes associated with Potential Archaeological Deposit (PAD) comprising subsurface artefacts and other objects or features).
4. Aboriginal historical site (camp, residence, mission, etc).
5. Stone procurement place and stone quarry.
6. Shell midden.
7. Cave and rock shelter with cultural sediment
8. Ceremonial ground (sometimes with earth or rock constructions).
9. Scarred tree.
10. Hatchet head grinding locality
11. Aboriginal burial (Aboriginal Ancestral Remains).
12. Rock art site.

These generally recognised site types are described below.

1. Isolated find

An isolated find, usually a single artefact or other cultural object, is defined by the absence of associated artefacts, cultural deposits or archaeological features. These finds may be indicative of random loss or deliberate discard of a single artefact, the remnant of a now dispersed artefact scatter, or a subsurface sedimentary horizon containing artefacts. They may occur anywhere within the landscape but are more frequently encountered in landscape units containing stone artefact scatters.

A conservative approach to artefact identification is required for isolated finds, especially when the find is a piece of fractured quartz. When artefact-size pieces of quartz, particularly relatively unweathered fragments of vein quartz, occur naturally in the sediment an identification of quartz items as artefactual must be based on definite evidence of knapping

A proportion of the artefacts deemed isolated finds are part of the background scatter or count of artefacts within a land unit. Background scatter or count refers to the widespread occurrence of artefacts that cannot be related to a focus of past activity involving stone discard. The 'background' is an accumulation of stone artefact loss and discards events occurring since first human settlement of that region, though erosion in a local area may only reveal artefacts from any recent prehistoric activity.

The type and frequency of isolated artefacts in a landscape unit will depend on a number of factors. These include the nature of past human settlement and exploitation in the region, the proximity and nature of the stone used for toolmaking, and a range of environmental factors such as the nature of sediments, degree of erosion and degree of ground surface visibility. Generally, there are no reliable estimates of background scatter for land units within different regions of Australia.

Isolated finds may indicate

- loss or discard of an artefact while away from a camp (while travelling);
- an isolated tool-making or resharpening event away from camp, where a group of artefacts is discarded on the ground;
- an encampment area, where artefacts occur within the sediment (and present-day erosion is minimal).

2. Isolated hearth

Aboriginal hearths (firepl ces) are an important archaeological feature of encampments and provide a range of archaeological evidence about prehistoric settlement and subsistence. These features often provide material for chronometric dating of the occupation event (Mitchell 1996) and some isolated hearths are extremely ancient.

Identifying hearths or anthropogenic hearths generally from the remains of natural occurring fire is often problematic There is a range of anthropogenic hearth types, including cooking pits, heat-treatment pits, work and sleeping fires, and ash dumps. Natural fire, such as a slowly burning tree stump, can bake clay sediment and leave a feature comprising a discrete area of burnt clay with charcoal and ash. This same polythetic set of features occurs after European forest clearance and burning of dried timber.

One way of distinguishing human-caused or archaeological fire is by its shape and size. Archaeological fires tend to be roughly circular in shape on the upper surface and basin-shaped in cross-section. Hearths diameter ranges between 20 to 30 cm and about 5 to 10 cm in depth (Mitchell 1996). Archaeological fire features may also appear as lenses of concentrated charcoal, blackened or reddened rocks and clay heat retainers (baked clay lump), and may also contain stone artefacts, cobble manuports and less commonly charred bone and shell. The shape of clay nodules in such a feature can be used to distinguish archaeological fire mounds from a burnt tree feature. Clay heat retainers are rounded nodules while natural baked clay sediment tends to be blocky or irregular in shape. Not uncommonly stone artefacts are flaked beside a fireplace and discarded flaking debris may show evidence of heating

Mitchell (1996) has identified a number of methods by which anthropogenic can be differentiated from natural fire. However, some of these methods have failed to produce a convincing or reliable result.

Magnetic susceptibility analysis of clay nodules fired at a temperature lower than 500ºC has failed to distinguish between natural and human caused fires (Mitchell 1996). However, other analytical methods that show promise are spatial analysis, macroscopic examination, microscopic analysis, particle size analysis and chemical analysis. For instance, spatial analysis may show clustering of charcoal patches, while macroscopic analyses can help identify rounded orange-red clay nodules as well as identify charcoal size range for analysis of particle size distribution. Experimentally, fire pits produced charcoal size larger than 3 mm. Microscopic analyses allow for identification of flaking microdebitage, fragments of charred bones and identification of species of wood that was burnt. In ideal circumstances, chemical analysis of baked clays can be used to identify organic residues such as exudates from tuber roasting.

3. Stone artefact scatter

When artefacts occur in sufficient concentration on a land surface unprotected by rock overhang the area is described as a stone artefact scatter. Other labels that have been used are: lithic scatter, artefact scatter, surface scatter, open site, open-air site, ‘open camp site, and ‘campsite’.

The stone artefact scatter is the most commonly reported Aboriginal prehistoric site type in Australia. In some regions devoid of rock shelters or caves, open sites (or stone artefact scatters) may be virtually the only type recorded in archaeological surveys. Stone artefact scatters are most likely to occur on level or low gradient land surfaces, along the crests of elevated flats on hills, ridgelines and spurs, in coastal sand dunes, and on slightly elevated flattish ground fringing watercourses and wetlands. Larger stone artefact scatters with subsurface artefact horizons tend to occur in the vicinity of major and/or reliable water sources.

Stone artefact scatters represent a range of different human activities or site uses. However, most are former open-air campsites, ranging in nature from a day camp by an individual or small group during a hunting and gathering trip, to a large, semi-sedentary base camp located at a reliable water source. Some important camping areas were reoccupied on a regular basis over hundreds

or even thousands of years.

Often, a scatter of stone artefacts and manuports (such as pebbles and burnt clays heat retainers) lying on the ground are the remains of an uppermost horizon of soil stripped of all but its heaviest items by wind and water erosion. In many instances, the artefact horizon is not removed entirely and there is still a horizon of artefacts (sometimes disturbed) and associated cultural features such as hearths in various spatial concentrations of habitation debris. Where a stone artefact scatter has an identifiable or inferred subsurface cultural horizon as well as artefacts on ground surface, the two kinds of archaeological deposit (surface and subsurface) comprise a single 'site'.

Usually a visual inspection of the artefacts on ground surface is not sufficient to accurately determine the extent of the subsurface concentration of artefacts. Commonly, the boundary of the subsurface cultural horizon is not well defined, and the count of artefacts gradually decreases with distance from a main concentration until it merges with the average background count for a land unit.

The stone artefacts and manuports in stone artefact scatters represents stone flaking and discard activities associated with manufacture and maintenance of tools, weapons and other items of material culture, or for processing plant food. The remains of hearths, and other cultural features, also may be present within the general area of the site. Artefact density can vary considerably across a site and between different sites in the same land unit.

Stone artefact scatters normally cannot be dated with any precision (within the last few thousand years is common) and they are often difficult to interpret from the small sample of material remains. While the site's size and its 'density' of artefacts are often taken as reflecting more intensive use of the site by people, a wide range of factors bears upon artefact density and site size, sufficient to limit any interpretation in the absence of professional excavation.

3.1. Bioturbation impact on site integrity

Determining the original positions and sequence in which artefacts were deposited at an open-air site often is complicated by a number of disturbance processes, such as downward soil creep on slopes, cracking of topsoil, tree growth, burrowing animals (in particular invertebrates), and human activity. Bioturbation of the soil horizon by ants, worms and termites is a significant cause of artefact sinking and mixing in soil layers (Cahen & Moeyerson 1977; Dean-Jones & Mitchell 1993:43, 46; Mitchell 1988:52; Moeyersons 1978; O'Connell *et. al.* 2018). Kamminga provided the first demonstration of invertebrate bioturbation of an open-air prehistoric site in southeast Australia (Kamminga *et al.* 1989:32-33), and there are a few other documented examples.

Tree growth and tree fall also cause bioturbation of cultural sediments (e.g. Photo 7). Gollan (1992:44) has estimated that in forested land of at least 100 trees per hectare tree growth would have would have caused extensive disturbance of sediments over a period of approximately 2,500 years. Dean-Jones and Mitchell (1993:43-44) have reported that tree fall tends to cause mixing of cultural objects (usually stone artefacts) out of stratigraphic order when sediment is washed

from the tree roots by rain. There are specific instances where this has been observed in action (Kamminga *et al.* 1989:27, 32-33). It should be noted however that most trees species in Australia do not signifi antly disturb the soil when falling, because the trunk breaks after weakened by fire, fungi and termites, and tends to remain in the ground.

In general, it is difficult to assess the effects of plant and animal bioturbation within open-air sites without first undertaking test excavations. in the first identification of invertebrate bioturbation of an open-air site in south-eastern Australia, Kamminga found by plotting artefacts weight distributions that there was a marked vertical dispersal of the lighter fraction (less than a gram) above and below a well-defined horizon of the heavier Aboriginal objects (Kamminga *et al.* 1989:32). This pattern could only be accounted for primarily by earthworm bioturbation. However, the effects are not always so clear. Bioturbation impacts are often relatively small-scale vertical and lateral movement of artefacts. In particular, invertebrate burrowing can result in different sizes and shapes of stone fragments sinking into the soil at different rates and eventually settling at the same level which is normally the lower limit of invertebrate activity (see review in Kuskie and Kamminga 2000).

3.2. Effects of ploughing on subsurface artefact horizons

Human activity at a site in prehistoric times may disturb original material patterns of former occupation. Manuports and artefacts may be moved around a camp during subsequent visits, re-used or even removed. In circumstances where site integrity is high, this subsequent activity may be inferred from the character and pattern of the preserved archaeological record. However, where bioturbation or pastoral practices have diminished site integrity, practically none of this may be evident.

Ploughing occurred soon after vegetation was cleared, especially on floodplains and lower slopes. Ploughing causes both vertical and horizontal movement of artefacts and manuports and is therefore a major cause of disturbance to artefact horizons within 20-30 centimetres of the ground surface. While the stump-jump plough cut a furrow no more than about six centimetres deep, later designs of ploughs and inevitable loss of some topsoil has meant that open-air sites in cleared land tend to be seriously disturbed. Ploughing causes both vertical and horizontal movement of artefacts and manuports, resulting in disturbance to original patterns of discard, either in their original discard configuration or after already affected to some degree by natural processes. Ploughing can also cause the destruction of archaeological features such as fireplaces. After several decades of ploughing, artefacts may be displaced laterally up to several metres. For all types of ploughing equipment, larger artefacts (more than 40 mm in size) tend to be moved the greatest horizontal distance (Roper 1976, Lewarch 1979:116-122, Lewarch & O'Brien 1981a, b). Smaller cultural objects tend to displace downward (Roper 1976). Ploughing also tends to destroy hearths and other cultural features in open-air sites.

4. Aboriginal historical site (camp site, mission site, etc)

Aboriginal lifestyle and settlement patterns changed significantly as British settlers colonised the continent. Surviving Aboriginal people often lost access to their traditional hunting and

foraging territories and a dependant relationship developed with the British settlers and colonial government. Aboriginal people settled in family groups on farms and camps were located at some of the British settlements.

In Australia, 'contact-period' base camps with intact old growth forest or woodland surrounding them tend to have a relatively large number of scarred trees in the vicinity. Artefact scatters may contain shells and the remains of hearths with burnt clay, and an assortment of items of British or colonial manufacture, such as buttons, clay pipe fragments, nails and other pieces of iron, and bottle and ceramic fragments. However, for a number of reasons, in northern interior NT scarred trees may not be that common in the vicinity of base camps.

5. Stone procurement place and stone quarry

Throughout Australia various stone and mineral substances were collected and sometimes quarried to make stone implements and pigments of various kinds (Hiscock and Mitchell 1993; Mulvaney and Kamminga 1999:27-31). Sandstone also was quarried in large slabs for use as grindstones in milling seeds for flou . Gravel beds and bars in watercourses were often ideal places to collect suitable stone, because they usually provided a choice of different stone types, and size and shape of pebbles and cobbles that had been water transported and therefore naturally tested for toughness. In areas where waterworn stones were collected from stream beds and relict river gravels the rejected and discarded flaking debris is often scattered about at or near the stone source. Where particularly desirable stone occurs, the discarded flaking debris may comprise thousands of items per square metre. Some larger stone collecting localities in the arid zone were extensive rock formations, where knapping debris is scattered over the ground for many kilometres. Rarely, stone procurement sites have quarry pits and shafts following a seam of high-quality stone or ochre. Around these pits are knapping floors or 'stone reduction sites', where the early stages of tool manufacture occurred. However, often prehistoric stone procurement places, and at creek beds in particular, there is little or no archaeological evidence of stone procurement: there are no concentrations of preliminary knapping debris and no quarry depressions or pits.

Certain Aboriginal quarries and mines possessed significance that transcended material needs. People did not always prefer the closest source but exchanged valuable goods or travelled through arid country to a more distant source for stone they believed was imbued with spiritual power.

6. Shell midden

Coastal and freshwater shell middens comprise mostly the remains of women's shellfish collecting activities.

Many of the larger coastal middens along the seaboard of south-eastern Australia have been quarried to obtain shells for lime burning and land fill. Typically, middens are located in coastal estuaries and on headlands and sand dunes along the coast, and inland within riparian zones of watercourses and the margins of lakes with relatively permanent water. Middens and shelly lenses may occur out in the open or in rock shelters. Sometimes a midden deposit is minimal, comprising only a thin shelly layer or lens, as is common for inland lakes or riverside spreads of

mussel shells. In other instances, middens are massive in size.

6.1. Types of middens

Ethnoarchaeological research in Arnhem Land has identified two kinds of Aboriginal shell middens – 'base camps' which were occupied continuously for long periods, and 'dinnertime camps', representing ephemeral campsites (Meehan 1982). These ethnographic categories are often used as a rule-of-thumb guide for interpreting prehistoric middens elsewhere in Australia.

Despite the importance of middens for archaeology and the impressive size of many of them, shellfish usually provided only a small part of the Aboriginal subsistence base. While shellfish are a staple food resource, they contributed probably no more than one tenth of dietary needs in most coastal regions. Of course, they were a more significant resource during lean times. Other littoral and marine resources were important to coastal people, as were the plant foods and game obtained from wetlands and adjacent forest or woodland environments both on the coast and inland.

6.2. Antiquity of middens

Accumulations of shell tend to preserve well over a long time because they generate their own alkaline sedimentary environment even in surrounding acidic sediment. Thus, middens and their carbonaceous content of shells, animal and human bones may survive for millennia. Because they fringe the present-day seashore the majority of coastal middens are less then 6,000 years old. Some inland middens are more than 20,000 years old but, like coastal middens, most of those located belong within recent millennia.

6.3. Midden identification criteria

Occasionally there is difficulty in distinguishing midden deposit from natural features such as shelly storm beach deposits and scrub fowl mounds. Sometimes a midden cannot be a natural formation because of its particular location. Commonly agreed criteria for the identification of Aboriginal midden deposits include the range of species (preference for edible, mature shellfish), usually restricted to one or two species such as oyster, *Anadara*, whelk and turbo shells, or freshwater mussel. This concentration of edible sized shells usually produces positively skewed size-frequency distributions. Natural shell accumulations by wave action are likely to contain random species and size samples. Other criteria for midden deposit are layers indicating cultural rather than natural deposition, the presence of stone and bone artefacts, and manuports (natural stone brought by humans, often as cooking stones), and the presence of various crustacean, fish, bird and mammal remains that are not likely to occur naturally.

7. Cave and rock shelter site with cultural sediment

True caves, created by water action and dissolution, are commonly found in limestone country. Large caves occur along the southern coast from Victoria to southwest Western Australia and others in Cape York Peninsula and southern Tasmania. Rock shelters are far more numerous and widespread than true caves. These shelters are formed by cavernous weathering by wind and water, usually of sedimentary rock such sandstone or quartzite, or by the inclination of large

boulders.

While caves and rock shelters are of particular interest to archaeologists they were not necessarily commonly used as campsites in prehistoric times. In general, Aborigines did not inhabit the deep and dark recesses of caves, but camped at their entrances, venturing deep into their passages only for special purposes. In some desert areas, rock shelters were normally inhabited only during heavy rain or dust storms and over a period of thousands of years may have been visited only occasionally.

The reason archaeologists concentrate on such places is that the accumulation of stratified and datable sedimentary deposits containing stone artefacts and other occupation debris are concentrated within a very limited area; in some case the cultural material in the deposit is sparse, in other cases it is abundant. The alkaline sediment in limestone caves and shelters preserves bone and shell much better than in other depositional contexts; in very dry cave deposits a wide range of organic materials may be preserved, including dried plant matter such as wood and resin. While most caves and shelters contain shallow deposits, excavations may penetrate many metres of cultural horizons containing food debris of animal bones and shells, plant materials and microscopic pollen and phytoliths (plant silica), ash and charcoal from campfires, debris from knapping stone, and discarded stone implements. These cultural materials provide the basis for reconstructing prehistory.

8. Ceremonial ground

Ceremonial rock arrangements and earthworks are found in many parts of Australia (Mulvaney and Kamminga 1999) and historical records and field surveys indicate that they occur commonly in parts of eastern Australia. Over a thousand are known from NSW and Queensland alone. Many former ceremonial grounds had no features or constructions, and their existence and location are evident only from historical records.

Ceremonial constructions such as rock arrangements and earthworks are always low features in the landscape and usually less than a metre high. There are however a range of different designs. Some were personifications of totemic beings who participated in creation dramas; others demarcated areas for particular ceremonial activities. The latter function possibly explains the many linear or circular arrangements of stones enclosing a clear area ranging from a few square metres to hectares in area. Many earth or piled stone features in Australia are identified as bora ring because of historical accounts of ‘bora’ ceremonies (initiation of boys) at such sites.

Construction of stone lined paths and concentric rings of earth or stones involved considerable labour to construct. Linear earthworks or pathways may link pairs of circles, one larger than the other.

There are also many examples of cairns, or large, single standing stones, some of which have religious associations.

The simpler the construction or feature the more difficulty it is to identify it as an Aboriginal relic. Some constructions have no distinctive cultural attributes and without confirmation from informants, they would be unrecognised as Aboriginal or even cultural features. The location and survey of stone arrangements, ranging from simple cairns to elaborate ground designs are a continuing challenge for archaeologists.

9. Scarred tree

Scarred trees are conspicuous markers of Aboriginal inhabitation of country that is now substantially different from its original state. As Long (2002:5) has noted, there are few agricultural regions in the world where the native living plants display in their fabric pre-modern human activity.

Scarred trees occur within the remnant forestlands and woodlands, and generally more frequently along the sea coast and close to reliable water sources such rivers, billabongs and swamps. However, they may occur almost anywhere. Following widespread clearance of forest and woodland, the number of mature trees suitable for bark removal would have been dramatically reduced. Culturally scarred trees are more likely to survive in state forests and reserves of various kinds (including road reserves). Thus, the few identified scarred trees have been found within remnant areas of native woodland and in narrow road reserves (c.f. Edmonds 1998:47; Kamminga and Grist 2000:78-80, 95-100; Paton 1993:17-18, 23, 25-26; Long 2002, 2005).

The wide range of uses to which bark was put is reflected in the size range of the scars, which for making canoe hulls can be up to six metres in length and two metres in width. ‘Canoe trees’ are concentrated along rivers and other suitable water bodies. Rectangular sheets also were used as roofing and walls of huts and shelters in regions in Australia with suitable tree species. Andrew Long postulates that large mature trees with straight trunks were chosen for construction sheets, and that commonly the width of the bark sheet was 50-75% of the tree’s circumference (Long 2002, 2005).

Smaller sheets cut from a curved trunk or thick limb and from burls were made into containers (carrying vessels) such as bowls and dishes. Other small sheets were used as supports for drying and scraping animal skins (mostly possum), at least in northern Victoria and the Hunter Valley in NSW where they have been documented, but probably more widely, and for bark shields in parts of south-eastern Australia. While bark artefacts of these kinds are widely documented in Australia, less conspicuous or minor uses of bark were for grave pit lining, carved bark sculpture used in corroborees, and cord and rope (the bark was stripped off the tree for making fishing lines, nets, string, climbing rope, etc). Other types of Aboriginal scarring include toeholds cut into the trunk or branches for climbing in pursuit of possums and other small arboreal animals or collecting eggs, nuts and honey, and resource extraction holes (Kamminga and Grist 2000:57; Long 2002, 2005). These features sometimes occur in association with bark procurement scars, and most often exhibit cut marks from a steel axe or hatchet.

Bark was procured from a range of tree species, some of which, such as River Red Gum, and species of box, stringybark and paperbark, were particularly useful for making constructions and

artefacts. Inevitably, due to natural death of trees, insect attack, bushfires and agricultural clearing, the number of scarred trees has diminished rapidly, and often they are now only encountered along wooded watercourses, and on the margins of lakes and swamps. Despite this dramatic reduction in numbers these relics are still being recorded in large numbers during archaeological field surveys.

Reliable identification of scars as Aboriginal is notoriously difficult Kamminga and Lance 2016), with considerable consequence for assessment of site significance and potential environmental impacts from development. It is often very difficult to distinguish Aboriginal culturally scarred trees from those made by or for settlers, who used bark most as cladding and roofing material (Kamminga and Grist 2000; Long 2002:3). Scars from the effects of fire, lightening, limb fall, faunal activity and modern human activity often have been wrongly interpreted as Aboriginal. Also, the bark around cultural scars regrow as 'callous tissue', especially around the sides of the scar – this regrowth often obscures the original shape of the scar and hatchet cut marks in the underlying wood. Over time the wood within Aboriginal scar degrades by weathering, bushfire or insect infestation, so that the essential for identification is lost. Finally, there are considerable difficulties in determining the age of living or dead scarred trees. Little information has been compiled on the maximum life spans of the tree species Aborigines exploited for bark, and in particular box and gum trees. Aboriginal Affairs Victoria advised in mid-2007 that only definite Aboriginal scarred trees should be registered. The manuals by Andrew Long, 'Scarred trees: a field identification manual', and 'Aboriginal scarred trees in New South Wales' are essentials guide to identifying and evaluating Aboriginal scarred trees (see also Kamminga and Grist 2000:56-65; Officer and Navin 1998:14; Officer 1992)

10. Hatchet-head grinding locality

One of the most important Aboriginal implements was the ground-stone hatchet, which is more commonly but less correctly known as the 'edge-ground axe' (Mulvaney and Kamminga 1999:32-34, 91-93). On current evidence, this implement first appeared in south-eastern Australia about 4500 years ago. The processes of fashioning and resharpening the hatchet head included the grinding of a cutting edge on an abrasive stone, usually found near water and close to campsites. At these places grinding grooves are worn into bedrock, which often is sandstone.

11. Aboriginal burials (Aboriginal Ancestral Remains)

In general, Aboriginal people regard burials as an extremely significant and sensitive site types (Mulvaney and Kamminga 1999:35-38) and removal of Aboriginal remains for reburial are undertaken only with guidance or supervision from the relevant Aboriginal community. There are also strict legal obligations relating to the recovery of Aboriginal and non-Aboriginal human remains.

Historical evidence indicates great diversity in Aboriginal mortuary practice throughout the continent during early historical times (Hiatt 1969). Burial practices included cremation bodies wrapped in soft bark, skin or matting and buried in a shallow grave, or cached within a hollow tree trunk or ossuary in rock crevices.

Ordinarily such remains are not encountered in archaeological excavations. However, development work and erosion continue to expose prehistoric human remains. Human burials are generally only visible where sub-surface sediments have been disturbed or where an erosional process has exposed them. Most often, they are found in rock shelter deposits and in sand bodies and in sandy or silty sediments. In valleys and plains, burials may occur in locally elevated topographies rather than poorly drained sediments. Burials rarely occur on rocky hilltops.

While the majority of recorded burials date to within the last few thousand years some are much more ancient. Large cemeteries occur along the Murray River, many of which had been established for millennia. A small number of Aboriginal cemeteries have been located in other regions and it is expected that in future years more will become apparent.

Study of such remains provides information about prehistoric nutrition, diseases, injuries, and long-term biological changes. Such studies also provide information about the nature of material culture, and cultural practices and belief systems of past generations. Fibre, animal skin and wood usually disintegrate rapidly after burial, and most graves lack surviving material relics. However, stone, animal bones, bone fishhooks, shells, pellet and powdered ochre, teeth necklaces, and bone pins and points have been recovered from some burials (Mulvaney and Kamminga 1999:35-38). The kinds of information gained about prehistoric culture and society are of importance not only to Aboriginal people but the wider Australian community.

12. Rock art site

Aboriginal rock art is the pictorial record of Australia's human past, and as such is a unique component of the archaeological record (Mulvaney and Kamminga 1999:369-82). This artistic expression provides insight into aesthetics and other social practices and beliefs. Innumerable rock art motifs survive throughout Australia as paintings, drawings, and pecked and abraded 'engravings', on open and sheltered rock surfaces. In most areas of Australia, paintings and engravings are intimately tied to contemporary Aboriginal beliefs and rituals of group or self-identity, sometimes requiring the periodic rejuvenation of motifs. Most surviving rock art in Australia dates within the last 3,000 years. Recent dating of thin encrustations on paintings demonstrates an antiquity of at least 25,000 years for some art in Cape York.

Much of the current research on Aboriginal rock art concerns the discovery, preservation and recording of the art. While many thousands of sites are on State site registers, only a fraction is individually recorded or described, while their conservation raises great problems. More than any other site type, Aboriginal rock art is part of the tourism industry in Australia and is widely recognised for its Aboriginal, aesthetic, scientific, historical and educational values.

The preservation of rock art is dependent on a combination of environmental factors including weather, surrounding plant communities, insect and animal activity, and the geological structure and durability of rock surfaces. Some art is preserved beneath a natural hard coating of silica that has built up on the rock surface. However, rock art usually deteriorates, sometimes at an

alarming.

Images were made on rock surfaces by two basic methods – the application of substances such as pigment or beeswax, and the physical removal of the rock surface by pecking or pounding. Pigment was mixed and applied as a liquid medium to form paint, or else drawn using a dry crayon or charcoal. Paint was also blown from the mouth around an object to create a stencilled negative. Almost all the red, yellow and brown pigments are derived from iron-rich minerals, like hematite ($Fe^2 2O^3$), commonly known as 'red ochre', siderite, a yellow-coloured iron carbonate, and goethite, a yellow to brown mineral which forms naturally as a weathering product from the other iron minerals. An impure version of goethite, the mineral limonite, which has a vitreous lustre, was also used. The colour of hematite paint ranges from various shades of red to mulberry, and even to blackish when the pigment has aged on a rock surface. Hematite is chemically stable and is durable on rock surfaces because its microscopically platy structure provides strong adherence properties. Charcoal, which normally provides black colouring, was ground and mixed as paint or applied from a charred stick. White mostly comes from kaolin clay. Some carbonate minerals have been identified, such as huntite, dolomite and calcite, which were ground to powder and mixed with water. All these white paints have poor preservation and poor adhesion, so they tend to flake off surfaces. Consequently, white pigment usually indicates that motifs are relatively recent.

Rock engraving involves pounding or 'pecking' the rock surface to expose lighter-coloured unweathered rock. The most common engraving technique was to pound a narrow groove as an outline of the motif. Intaglio, or the pecking of an area of stone to form a negative impression of the image, was also practiced. Engravings are found commonly on stone softer than quartzite (sandstone, limestone, various indurated sediments, fine-grained granite and dolerite) and where the sub-surface is much lighter in colour than the weathered 'skin', so that the visual effect is dramatic. Sometimes a rock pavement that was particularly favoured or ritually significant is densely engraved for over hundreds of square metres.

Stencils are a specialised technique for creating an image of a real object, distinct from most other forms of art which rely on the free-hand interpretation of the artist. Most stencils are of hands; others are of animals, plants and artefacts. Hand stencils probably represent a pictorial signature, and ones of hematite may last for many thousands of years. The most elaborate use of stencil motifs in a narrative or artistic composition occurs in the sandstone country around the Carnarvon Range in southern Queensland.

Appendix 2 - References

Bell, David 1979. Aboriginal carved trees in New South Wales: a survey report. Part 1. Report to NSW National Parks and Wildlife Service.

Berndt, Ronald and Catherine Berndt 1996. *The world of the first Australians. Aboriginal traditional life past and present*. Aboriginal Studies Press, Canberra.

Cahen, D. and J. Moeyersons 1977. Subsurface movements of stone artefacts and their implications for the prehistory of Central Africa. *Nature*, 266:812-5.

Clarke, Philip 2003. *Where the ancestors walked*. Allen and Unwin, Sydney.

Dean-Jones, P. and P.B. Mitchell 1993. Hunter Valley Aboriginal sites assessment project: environmental modelling for archaeological site potential in the central lowlands of the Hunter Valley. Unpublished report to NSW National Parks and Wildlife Service.

Edmonds, Vanessa 1998. The Wimmera River Cultural Heritage Study. Stage II. The Middle Wimmera Basin. Report to Goolum Goolum Aboriginal Cooperative, Horsham. Archaeological Consulting Services, Buronga, NSW. February 1997.

Frankel, David 1982. Earth rings at Sunbury, Victoria, *Archaeology in Oceania*, 17:89–97.

Frankel, David 1991. *Remains to be seen: archaeological insights into Australian prehistory*. Longman Cheshire, Melbourne.

Gollan, Klim 1992. Aboriginal cultural heritage study: northeast Forests, New South Wales. Unpublished report to NPWS.

Gorecki, Pawel and Mary Dallas 2000. Aboriginal archaeological assessment. Johns Road, Wadalba, NSW. Report to Wyong Shire Council, NSW.

Hiatt, Betty 1969. Cremation in Aboriginal Australia, *Mankind*, 7:104-19.

Hiscock, P. and S. Mitchell 1993. *Stone artefact quarries and reduction sites in Australia: towards a type profile*. Australian Government Publishing Service, Canberra.

Kamminga, Johan 2003. Aboriginal Heritage Study, Beachcomber Holiday Park, Eurobodalla National Park, NSW. Report to NSW National Parks & Wildlife Service, Far South Coast Region Office, Narooma. National Heritage Consultants, Canberra.

Kamminga, Johan & M. Grist 2000. Yarriambiack Creek Aboriginal heritage study and conservation plan. Kamminga Archaeology report to Aboriginal Affairs Victoria.

Kamminga, Johan & A. Lance 2016. Vickery Extension Project – Scarred tree assessment. Report to Whitehaven Coal Limited. Heritage Consulting Australia Pty Ltd. May 2016.

Kamminga, Johan, Robert Paton and Ingereth Macfarlane 1989. Archaeological investigations in the Thredbo Valley, Snowy Mountains. Anutech Pty Ltd report to Faraba Pty Ltd.

Kuskie, Peter and Johan Kamminga 2000. Salvage of Aboriginal archaeological sites in relation

to the F3 Freeway near Lenaghans Drive, Black Hill, New South Wales. Southeast Archaeology Report to Major Projects, Northern Region, Roads and Traffic Authority of NSW. (3 vols).

Lewarch, D.E. 1979. Effects of tillage on artifact patterning: a preliminary assessment. In Cannon Reservoir Human Ecology Project-A regional approach to cultural continuity and change. In M.J. O'Brien and R.E. Warren (Eds), *Technical Report 79-14*, pp. 101-149. Division of Archaeological Research, University of Nebraska, Lincoln.

Lewarch, D.E. and M.J. O'Brien 1981a. The expanding role of surface assemblages in archaeological research. In Schiffer, M.B. (Ed.), *Advances in archaeological method and theory*. Volume 4. Academic Press, New York.

Lewarch, D.E. and M.J. O'Brien 1981b. Effect of short term tillage on aggregate provenience surface pattern. In M.J. O'Brien, and D.E. Lewarch (Eds), *Plowzone archaeology: contributions to theory and technique*. Vanderbilt University, Tennessee.

Long, Andrew 2002. *Scarred trees. A field identification manual.* Aboriginal Affairs Victoria. Compiled by Harry Webber. Department of Natural Resources and Environment, Melbourne. (The manual is available online).

Long, Andrew 2005. *Aboriginal scarred trees in New South Wales: a field manual*. Department of Environment and Conservation (NSW), Hurstville. Archive version: http://nla.gov.au/nla.arc-55351.

Meehan, Betty 1982. *Shell bed to shell midden*. Australian Institute of Aboriginal Studies, Canberra.

Mitchell, Catherine 1996. Interpreting charcoal patches on open-site archaeology: need we be stumped for an answer? BA Honours thesis, Department of Archaeology and Paleoanthropology, University of New South England.

Mitchell, P. 1988. The influences of vegetation, animals and micro-organisms on soil processes. In H.A. Viles (Ed.), *Biogeomorphology*. Basil Blackwell Ltd, Oxford.

Mulvaney, John and Johan Kamminga 1999. *Prehistory of Australia*. Allen and Unwin, Sydney.

Moeyersons J. 1978. The behaviour of stones and stone implements buried in consolidating and creeping Kalahari sands, *Earth Surface Processes*, 3:115-128.

O'Connell, James F. Jim Allen, Martin A.J. Williams, Alan N. Williams, Chris S.M. Turney, Nigel A. Spooner, Johan Kamminga, Graham Brown, Alan Cooper, 2018. When did *Homo sapiens* first reach Southeast Asia and Sahul? *Proceedings of the National*

Academy of Sciences, 115(34): 8482–8490.

Office , Kelvin 1992. An archaeological investigation and management assessment of an Aboriginal scarred tree: 'Gunderoo Drive Four', Gungahlin, ACT. Navin Officer Archaeological Resource Management report to R.A. Young and Associates Pty Ltd.

Office , Kelvin and Kerry Navin 1998. Cultural heritage assessment, Proposed Visy Pulp and Paper Mill, Gadara Plains, Tumut, NSW. Report to Nolan-ITU Pty Ltd.

Roper, D.C. 1976. Lateral displacement of artefacts due to plowing, *American Antiquity*, 41:372-375.

Tindale, N.B. 1974. *Aboriginal tribes of Australia. Their terrain, environmental controls, distribution, limits and proper names*. University of California Press, Berkeley.

Appendix E: Primary Erosion and Sediment Control Plan

Erosion & Sediment Control Plan
EP 161
Santos

www.ecoz.com.au

DOCUMENT CONTROL RECORD

Job	EZ19041
Document ID	177686-25
Author(s)	Tim Elder

DOCUMENT HISTORY

Rev	Reviewed by	Approved by	Issued to	Date
1	A. Campbell	T. Elder	Client	13 May 2019
2	A. Campbell	T. Elder	Client	29 May 2019

Recipients are responsible for eliminating all superseded documents in their possession.

EcOz Pty Ltd.
ABN: 81 143 989 039
Level 1
70 Cavenagh St
DARWIN NT 0800
GPO Box 381, Darwin NT 0800

Telephone: +61 8 8981 1100
Facsimile: +61 8 8981 1102
Email: ecoz@ecoz.com.au
Internet: www.ecoz.com.au

RELIANCE, USES and LIMITATIONS

TABLE OF CONTENTS

Appendices

Tables

Figures

ACRONYMS

AEP	Average Exceedance Probability
BOM	Bureau of Meteorology
CPESC	Certified Professional in Erosion and Sediment Control
DENR	NT Department of Environment and Natural Resources (Northern Territory)
DPIR	NT Department of Primary Industry and Resources
EHS	Environment Health and Safety
EMP	Environment Management Plan
EP	Exploration Permit
ESC	Erosion and Sediment Control
ESCP	Erosion and Sediment Control Plan
IECA	International Erosion Control Association
NT	Northern Territory
RCD	Rock Check Dam
RFD	Rock Filter Dam
RUSLE	Revised Universal Soil Loss Equation
SMS	Santos Management System

1 INTRODUCTION

Santos QNT Pty Ltd (Santos) is the operator of Exploration Permit (EP) 161 which is located approximately 350 km south-east of Katherine in the Northern Territory (NT) on Tanumbirini Station (Santos 2019a). Santos has prepared and submitted separate Environmental Management Plans (EMP's) to the Northern Territory (NT) Department of Environment and Natural Resources (DENR) for each of the proposed 2019 McArthur Basin Civil and Seismic Program; and the McArthur Basin Drilling Program at the Tanumbirini and Inacumba locations.

Santos have engaged EcOz Environmental Pty Ltd (EcOz) to develop the Primary Erosion and Sediment Control Plan (ESCP) associated with the 2019 exploration activities

1.1 Purpose and objectives

This ESCP has been prepared to provide a best-practice framework for implementation of effective erosion and sediment control associated with Santos' work activities within the project area.

Objectives of the ESCP are:

- To take all reasonable and practical measures to minimise actual or potential environmental harm resulting from soil or water movement resulting from work activities
- To maintain, and where practical, enhance the land use capabilities of disturbed areas with respect to land's soil, water and vegetation attributes.
- To prevent soil loss from the site and deposition offsite; and minimisation of associated risks to water quality and air quality.
- To ensure satisfactory stabilisation of the site at completion of works.

1.2 Scope

The Primary ESCP provides the overarching ESCP demonstrating general drainage, erosion and sediment control principles, practices and methods to be implemented throughout project. This plan may be used to inform preparation of further Progressive ESCP's (where required), that provide detailed site-specific controls relevant to proposed exploration activities.

The ESCP has been prepared and certified by a Certified Professional in Erosion and Sediment Control (CPESC) in accordance with the guideline Best Practice Erosion and Sediment Control (IECA 2008). The ESCP:

- Identifies areas vulnerable to erosion and sedimentation (including receiving waters).
- Includes an overarching erosion risk and hazard assessment.
- Details the management strategy and specific measures to be implemented to effectively manage erosion, and potential sediment mobilisation associated with the project activities.
- Includes details of both temporary and permanent erosion and sediment control methods and treatments to be implemented for all stages of the project (pre, during and post works).
- Includes information regarding proposed timing and staging of works, site manager contact details, maintenance and monitoring requirements, and reporting procedures.

2 PROJECT AREA

2.1 Project location

The project area is Exploration Permit 161 within Tanumbirini Station, located on the Carpentaria Highway south east of Katherine, within NT Portion 701 of Arnold (Figure 2-1).

2.2 Project components

2.2.1 Seismic and civil program

Santos proposes to undertake a two-dimensional (2D) Seismic Program comprising a single 10 linear km 2D seismic line, in a northwest to southeast orientation across the Tanumbirini-1/2H well. Santos also proposes to complete civil works to support both this program and the future proposed Drilling Program at Tanumbirini and Inacumba wells (Santos 2019). The following key activities are included:

- Vegetation clearing
- Grading, excavation, stockpiling, compaction of soil material
- Respreading of any removed vegetation on the seismic lines following completion of the program, to promote regeneration
- Removal of all surface infrastructure (unless otherwise requested by landholder) and rehabilitation.

2.2.2 Drilling program

The 2019 drilling program includes the following key activities:

- Drilling of Inacumba-1 pilot well
- Plug and Abandonment of the deepest section of the Inacumba-1 pilot well
- Drilling of Inacumba-1H horizontal well from the Inacumba-1 pilot
- DFIT of Tanumbirini-1
- Drilling of Tanumbirini-2H well
- Well integrity monitoring
- Evaluation of Inacumba-1/1H and Tanumbirini-2H
- Suspension and/or Plugging and Abandonment of Tanumbirini-2H and Inacumba-1/1H
- Rehabilitation of the Tanumbirini-1, Tanumbirini-2H and Inacumba-1H wells.
- Drilling of an impact monitoring bore (Santos 2019a)

The location of key project infrastructure is provided in Figure 2-2.

2.3 Extent of ground disturbance

Civil works involve vegetation clearing; grading, excavation, stockpiling and compaction of soil material, establishment of material borrow pits, provision of construction access and drilling of wells, as described below.

2.3.1 Access roads

Access to Tanumbirini-2 will be along existing station access roads. The existing 13.2 km landowner access road from the Carpentaria Highway to the Tanumbirini-1 T-Junction may require minor upgrades, which will not increase the width of the road, but will require access to fill.

It is estimated that approximately 2,500 m^3 of additional capping may be required to reinstate the existing road and provide effective drainage to maintain vehicular access on the existing landowner access track.

A new section of road approximately 1300 m length x 8 m width is required to allow for placement of the new infrastructure. It is estimated that approximately 1,780 m^3 of rock/clay rubble will be required to cap this new section of access road.

Santos have identified two options for access to Inacumba-1 well:

- Option 1 – Total Distance 13.5 km uses 11.5 km of existing landowner access route then requires a 900 m minor deviation around landholder infrastructure to intersect 1.1 km of wellsite loop/access roads.
- Option 2 – Total distance 13.9 km, uses existing 12.1 km of landowner access. This option goes past the deviation required for Option 1, before turning south east 700 m along a seismic line to intersect 1.1 km of wellsite loop roads.

These options are further detailed within the document *Environment Management Plan: McArthur Basin 2019 Civils and Seismic Program* (Santos 2019).

2.3.2 Lease pads

The proposed infrastructure at both well locations (Tanumbirini-1/2H and Inacumba) will consist of:

- well pad
- campsite
- storage pad
- two water tank pads
- and a water bore pad.

Areas will be cleared, with vegetation and topsoil stockpiled separately for rehabilitation. Construction of this infrastructure will require disturbance of 6.5 ha for Tanumbirini; and 5.7 ha for Inacumba; with additional adjacent fire protection zones to be selectively cleared and managed (Santos 2019).

2.3.3 Borrow pits

Borrow pits are required to source suitable clay/gravel fill for access road lease pad construction. For Tanumbirini, two pit locations have been identified – an existing borrow pit located 6 km from the lease pad; and a second new pit directly adjacent to the lease pad (Figure 2-1). Estimated material requirements for Tanumbirini are 11,430 m^3 of clay/gravel select fill.

The proposed infrastructure construction for the proposed Inacumba 1/1H lease pad and access roads will require approximately 28,000m^3 of clay/ gravel select fill. Currently there are no established gravel sources within 10 km of this location. Five areas of investigation have been selected for possible gravel sources, located within two borrow pit areas (Figure 2-1).

Final volumes extracted from borrow pits may vary and will depend on the resource quality and quantity, however approximate areas of each borrow pit will be 200 m x 100 m x 3 m deep.

2.3.4 2D seismic profiling

The aim of the seismic survey is to produce detailed images of the various rock types and their location beneath the earth's surface. This information is used to determine the location and size of oil and gas reservoirs.

Line preparation is undertaken prior to acquisition to provide safe access and a defined line for the acquisition crew to follow. Due to varying terrain, the line preparation is usually undertaken by a dozer/grader and a light 4WD vehicle. The dozer will 'walk' with the blade up in easily traversable terrain, with the marks of the dozer tracks being sufficient for the surveyors and recording crew to follow. The dozers will not be utilised in areas where riparian vegetation is present.

Surveying commences shortly after line preparation. Each survey team consists of one surveyor in a light 4WD vehicle, and generally makes only one pass over any given section of line. Back tracking may occur in areas where vehicle access routes have deviated from the true line position and markers must be inserted by personnel on foot. This may occur in areas of riparian vegetation if there is adequate access either side of the watercourse.

Recording normally commences two to three weeks after the start of line preparation once the entire 10km line has been laid out on the ground (Santos 2019).

2.3.5 Airstrip maintenance

The landowner airstrip adjacent the Tanumbirini Homestead may be used for crew changes and emergency response evacuations. The 1,400 m length airstrip is a dry weather strip and contains no lighting and is regularly used to deliver landowner mail and other irregular private aircraft.

The airstrip surface is unsealed and requires annual maintenance to control ant mound growth, repair erosion and remove vegetation which has emerged following the wet season. Proposed works at the airstrip include maintenance grading and rolling of the entire runway, parking areas and signal areas to restore the surface and repair any minor erosion following the wet season. In addition, regular maintenance watering may be required on the airstrip access and runway to maintain the surface and control dust. All proposed maintenance works will be limited to the cleared airstrip footprint and no new clearing will be required (Santos 2019).

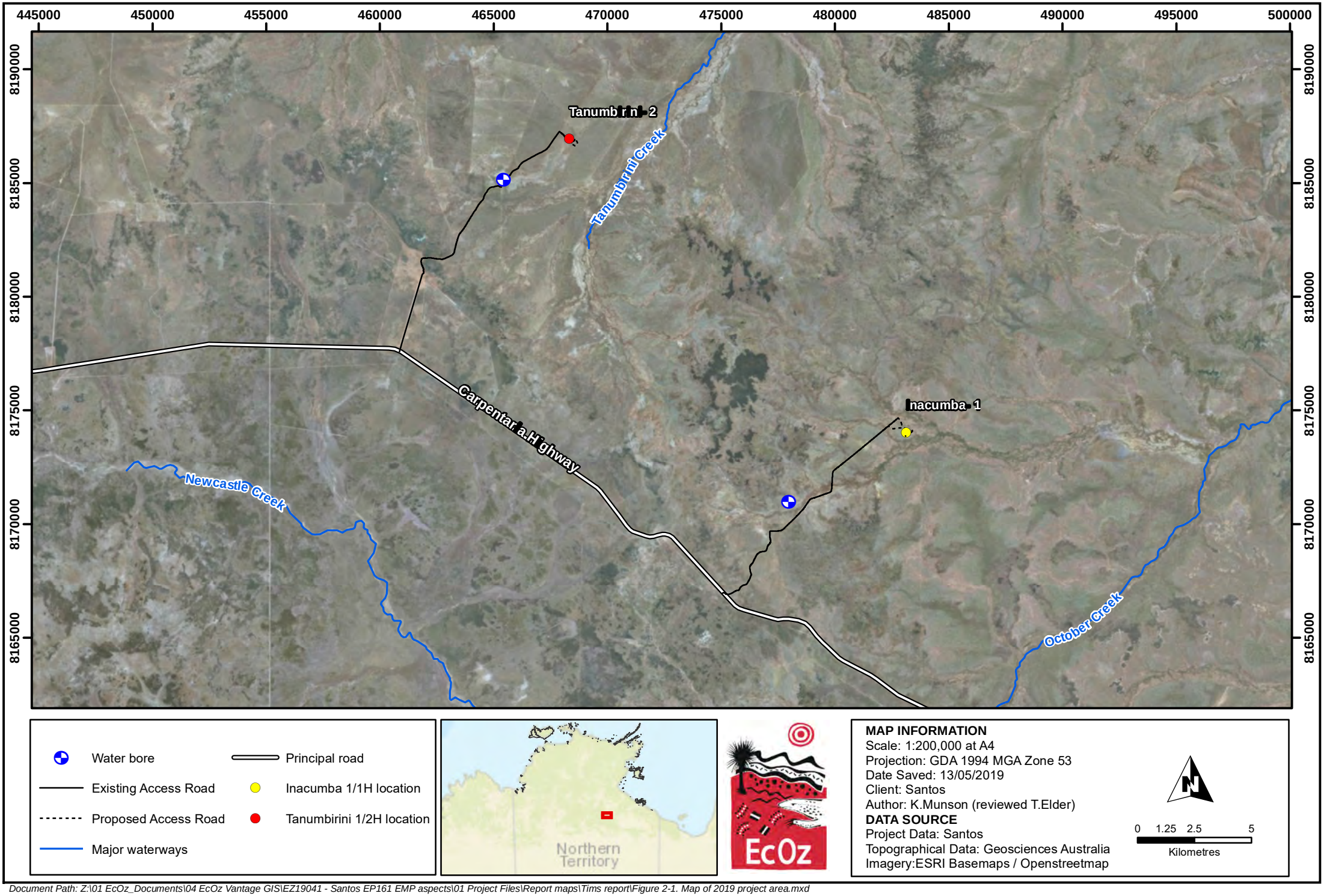
2.4 Project schedule

The Drilling Program is expected to take up to 17 weeks and will be undertaken in the 2019 dry season. An indicative project schedule is provided in Table 2-1. The project will be carried out in 12-hour day shifts where possible (Santos 2019a).

Table 2-1. Indicative project schedule (Santos 2019 & 2019a)

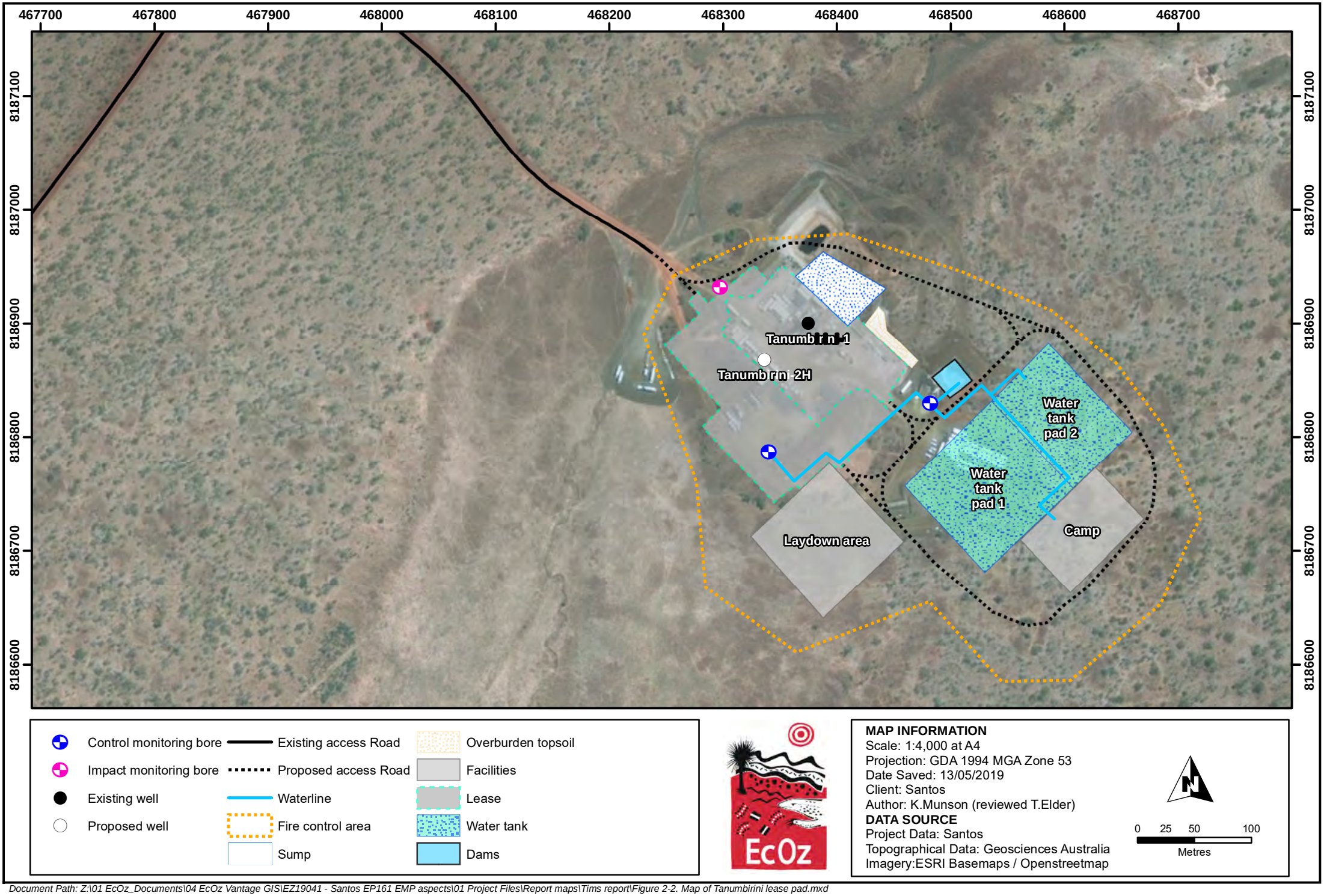
Activity	Estimated duration	Estimated commencement
Civil works	4 – 12 weeks	May 2019
Seismic data acquisition	1 – 2 weeks	May – June 2019
Rehabilitation of seismic lines	1 week	May – June 2019
Mobilisation of drilling equipment	4 weeks	May – Jun 2019
Drilling and well evaluation	15 – 25 weeks	Jun – Jul 2019
DFIT	4 weeks	Jun – Jul 2019
Demobilisation of equipment	2 – 4 weeks	Nov – Dec 2019

Well Suspension and/or Plugging and Abandonment	4 weeks	To be determined
Rehabilitation post well suspension	1 – 2 weeks	To be determined
Rehabilitation post-decommissioning of wells	2 – 4 weeks	Commence within 12 months of decommissioning
Post-rehabilitation monitoring	2 weeks per monitoring event	• Immediately after well completion • Immediately after rehabilitation works completed post decommissioning • Following first wet season • Three years after decommissioning



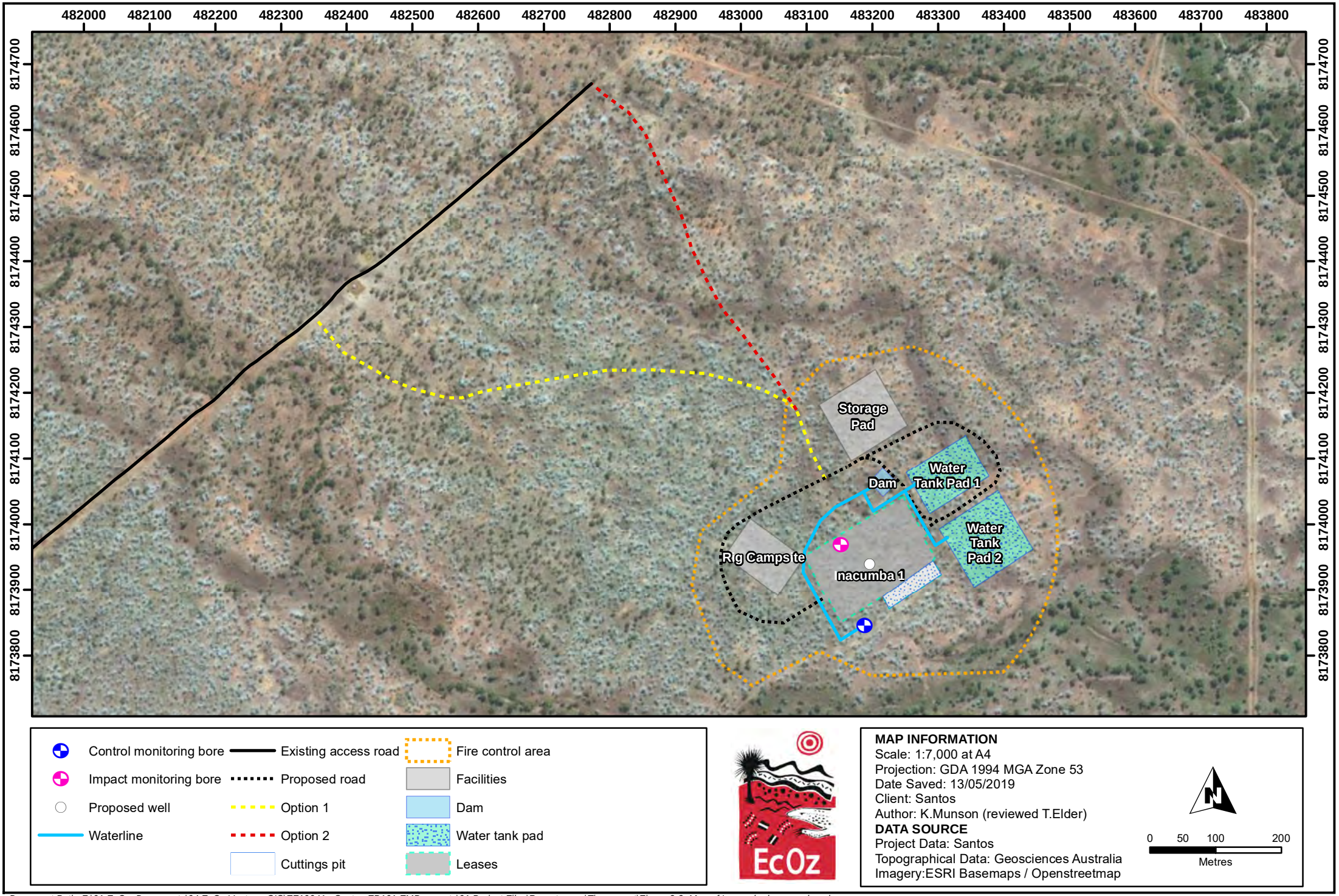
Document Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19041 - Santos EP161 EMP aspects\01 Project Files\Report maps\Tims report\Figure 2-1. Map of 2019 project area.mxd

Figure 2-1. Map of 2019 project area



Document Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19041 - Santos EP161 EMP aspects\01 Project Files\Report maps\Tims report\Figure 2-2. Map of Tanumbirini lease pad.mxd

Figure 2-2. Map of Tanumbirini lease pad



Document Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19041 - Santos EP161 EMP aspects\01 Project Files\Report maps\Tims report\Figure 2-3. Map of Inacumba lease pad.mxd

Figure 2-3. Map of Inacumba lease pad

3 SITE CHARACTERISTICS

3.1 Climate and rainfall

The project is located in a semi-arid, subtropical climatic region. The area experiences two distinct seasons - a dry season with little/no rainfall between approximately May to October, and a monsoonal wet season from November to March. Weather statistics are from the Tanumbirini weather station.

Figure 3-1 provides a summary of climate information; January and February are the wettest months, both with over 150 mm annual rainfall on average. There is little to no rain from May through to September (when the majority of civil works will be undertaken). June and July are the coolest months, with an average maximum of 29ºC, contrasting with an average maximum of 38ºC in the hottest month of November.

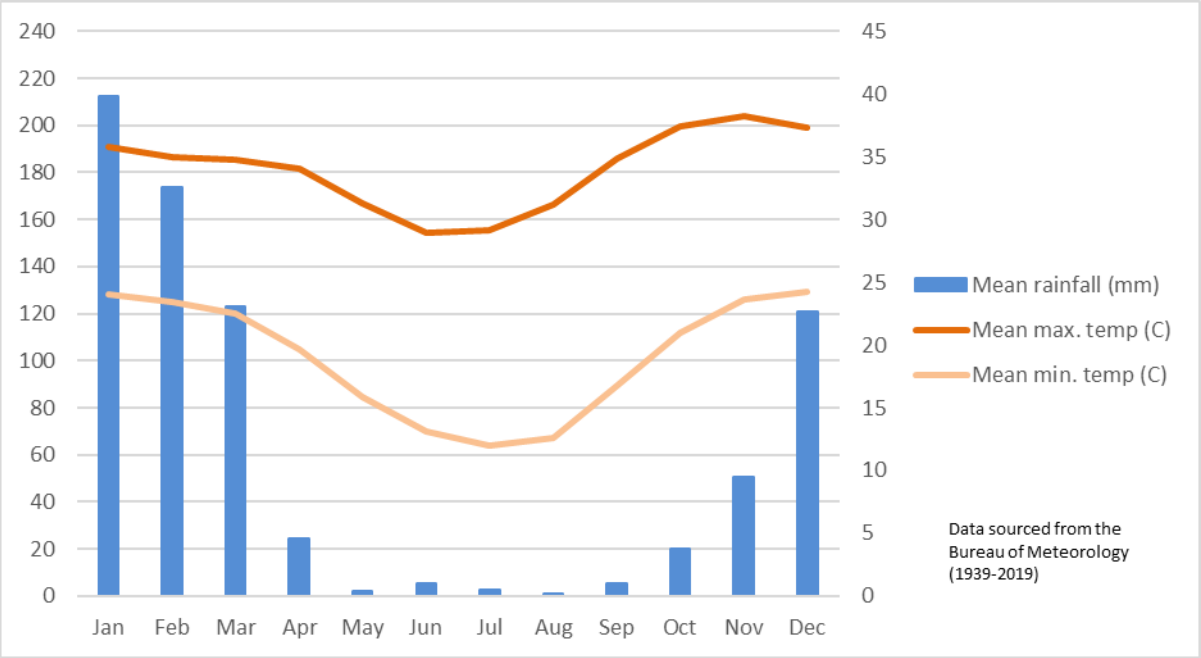


Figure 3-1. Average monthly temperature and rainfall, Tanumbirini, NT

3.2 Topography

Tanumbirini Station is situated on the north eastern boundary of the Beetaloo Basin, approximately 250-280 metres above sea level at the Carpentaria Highway (Fulton and Knapton 2015). The station is situated on a drainage divide that separates inland drainage of the Sturt Plateau from the north east flowing streams that lead into the Gulf of Carpentaria. To the west and south west are gently undulating plains of the Sturt Plateau, and to the north and east towards the Gulf of Carpentaria are laterite plains. Formed by laterite capping on Cretaceous aged sedimentary rocks, the undulating terrain is characterised by scattered low, steep hills and dissected plateaux on exposed Proterozoic and Palaeozoic sedimentary rocks (Fulton & Knapton 2015).

3.3 Land systems

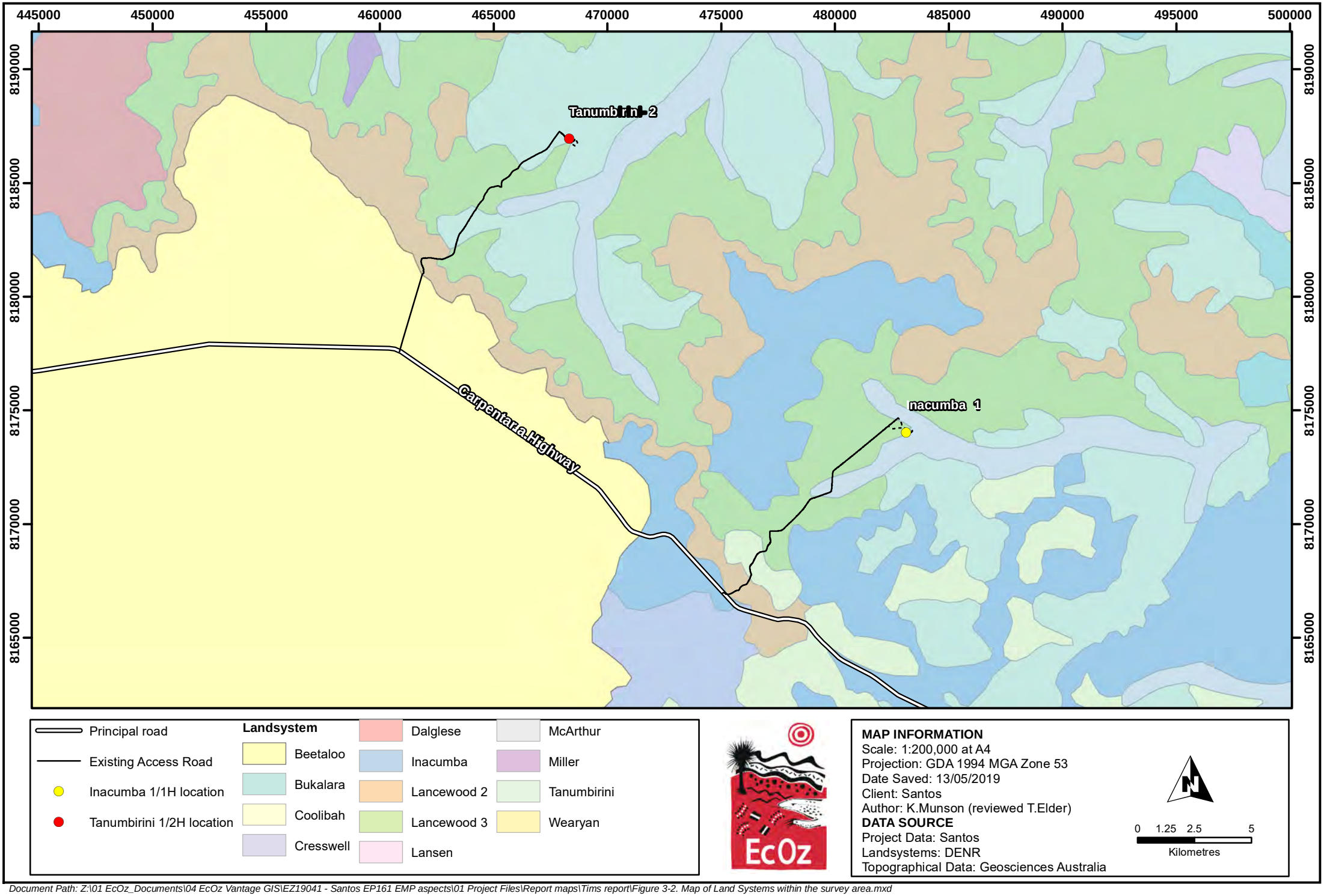
Land systems within the survey area were determined using the *Land Systems of the Northern Part of the NT (1:250,000)* dataset (DENR 2008) and the *Land Systems of the Southern Part of the NT (1: 1,000,000)*

dataset (DENR 2011). Land systems were verified through on-ground assessment of landform and vegetation characteristics.

There are seven land systems mapped within the survey area (Table 3-1 and Figure 3-2). The land systems within the survey area consist primarily of lateritic plains, lateritic plateau, alluvial plains, and sandstone plains and rises. The landform and vegetation characteristics at each of the survey sites corresponded to the mapped land system.

Table 3-1. Land systems within the project area (Santos 2019)

Land System	Landscape Class	Class Description	Landform	Soils	Main vegetation*	% of total area
Beetaloo (BE)	Lateritic plains and rises	Plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products; sandy and earth soils	Plains and rises on weathered sedimentary rocks	Red clayey sands, red earths and texture contrast soils	*Acacia shirleyi* Lancewood forest	< 1%
Coolibah (Tac)	Alluvial floodplains	Alluvial floodplains, swamps, drainage depressions and alluvial fans; sandy, silty and clay soils on Quaternary alluvium	Level to gently undulating plains on unconsolidated, transported materials, rarely sedentary	Aquic Vertosols; sandy, silty and clay soils on Quaternary alluvium	Mid high open woodland of *Eucalyptus microtheca* with some *Excoecaria parvifolia* and Corymbia *papuana*	1 %
Inacumba (Lwi)	Lateritic plains and rises	Plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products; sandy and earth soils	Plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products	Sandy and earth soils	Mid-high open woodland of *C. dichromophloia, E. miniata, E. tetrodonta,* over *Eriachne spp, Chrysopogon fallax, Triodia pungens*	35 %
Lancewood 2 (Lwl)	Lateritic plateaux	Plateaux, scarps and some rises on deeply weathered sediments; shallow soils with rock outcrop	Plateau margins, escarpments and rugged low hills and plateaux	Lateritic lithosols	Mid-high open forest of Acacia shirleyi over Schizachyrium fragile, Chrysopogon fallax, Triodia bitextura	< 1 %
Lancewood 3 (Lwl)	Sandstone plains and rises	Plains, rises and plateaux on mostly on sandstone, siltstone, claystone, shale and some limestone; commonly shallow soils with surface stone and rock outcrop	Crenulate escarpments, rugged low hills and gently undulating lower slopes on actively eroding, ferruginised Lower Cretaceous sediments (claystone and laterite)	Grey and Brown Vertosols and Leptic Rudosols; shallow soils with rock outcrop	Mid high open woodland of *E. pruinosa* with areas of mixed grasslands, *Acacia shirleyi* on cliffs and slopes	25 %
McArthur (Tam)	Alluvial floodplains	Alluvial floodplains, swamps, drainage depressions and alluvial fans; sandy, silty and clay soils on Quaternary alluvium	Broad or narrow fluvial corridors conducting regional drainage across various Land Systems towards the coast	Aquic Vertosols, Red and Yellow Kandosols and Orthic Tenosols; sandy, silty and clay soils on Quaternary alluvium	Mid high open woodland of *E. microtheca;* tall fringing riparian vegetation often including *Melaleuca* spp.	2 %
Tanumbirini (Tct)	Lateritic plains and rises	Plains, rises and plateaux on mostly on sandstone, siltstone, claystone, shale and some limestone; commonly shallow soils with surface stone and rock outcrop	Plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products	Lateritic yellow earths and brown clays	Mid-high open woodland of *Eucalyptus chlorophylla, Erythrophleum chlorostachys,* over *Chrysopogon fallax, Eulalia fulva, Triodia pungens*	36 %



Document Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19041 - Santos EP161 EMP aspects\01 Project Files\Report maps\Tims report\Figure 3-2. Map of Land Systems within the survey area.mxd

Figure 3-2. Map of Land Systems within the survey area

3.4 Surface water

The Project Area is located in the headwaters of the Limmen Bight River catchment, which drains north easterly towards the Gulf of Carpentaria (refer Figure 3-3 and Figure 3-4). Rivers include the Limmen Bight River and its tributary, the Cox River (DENR 2019). The highest flows for these rivers occur during the wet season, predominantly due to cyclones and monsoonal rainfall. In contrast to these larger rivers, smaller ephemeral braided streams and drainage lines such as the Tanumbirini Creek and October Creek to the north, and Newcastle Creek to the south. Ephemeral rivers and streams are subject to short flow duration and high turbidity. There is also a range of small wetlands associated with springs, sinkholes and minor depressions in the generally flat landscape. Riparian zones of these rivers and wetlands are generally in fair to good condition, affected mostly by livestock and feral animals and weeds (Santos 2019a)

3.4.1 Flood modelling

Flood modelling results indicate the lease pad at the Tanumbirini 1/2H location will be subject to minor flooding during a 1 in 10 AEP flood event. That flooding extends to an average depth of 1 to 1.5m during a 1 in 100 AEP flood event. However, the supporting infrastructure areas, including the camp, tank pads and laydown areas in the south east, remain unaffected by a 1 in 100 AEP flood event. The Inacumba 1/1H location including the lease pad and the supporting infrastructure areas remains mostly unaffected in a 1 in 100 AEP flood event (Santos 2019a)

3.5 Soils

The project area soils are dominated by kandosols and rudosols. Rudosols are very shallow soils or those with minimal soil development and include very shallow rocky and gravely soils across rugged terrain. Kandosols are massive and gravelly soils (formerly red, yellow and brown earths) that are widespread across the Sturt Plateau bioregion.

3.5.1 Soil sampling and analysis

Soil sampling was undertaken across the project area (Figure 3-3 and Figure 3-4), with subsequent laboratory analysis of a range of physical and chemical characteristics. A summary of the key parameter results are provided within Table 3-2.

Soil texture

Soil texture is the principal component affecting soil erodibility (structure, organic matter and permeability also contribute – refer Section 4.1.2).

Emmerson aggregate class

The Emerson Class is determined from the Emerson Aggregate Test, and eight-class classification describing the behaviour of air-dried aggregates when placed in distilled water. Specifically, it describes whether the soil aggregates slake or disperse. Soil erodibility factors are required to be adjusted upwards for Emerson Class 1 and 2 soils (strong to moderate dispersion). Results from collected samples do not indicate significant soil dispersion risk.

Cation exchange capacity

Cation exchange capacity (CEC) is a useful indicator of soil fertility (and therefore rehabilitation) because it shows the soil's ability to supply three important plant nutrients: calcium, magnesium and potassium. The higher the CEC, the more able the soil is to hold plant nutrients.

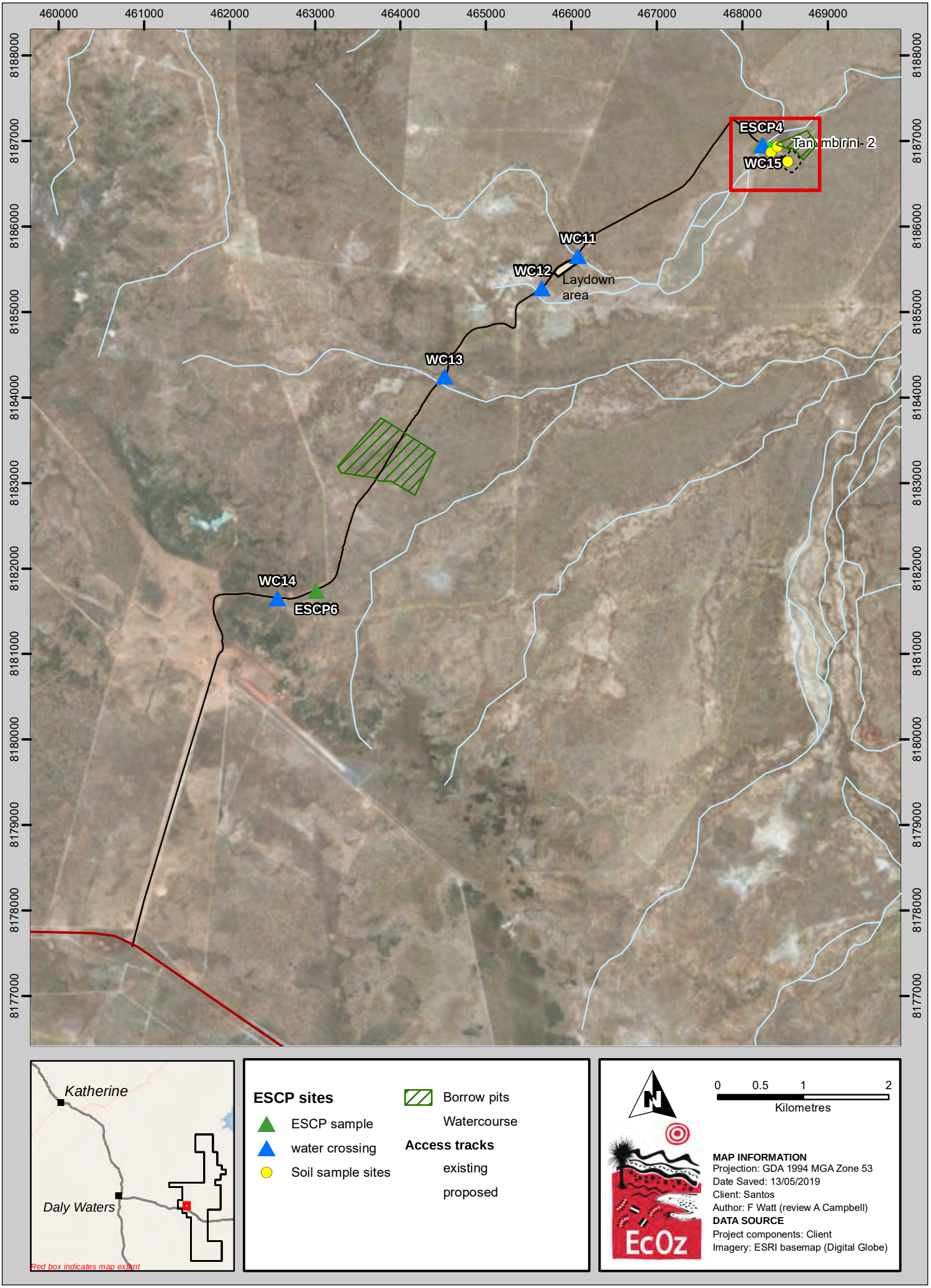
The desirable ranges for them are: calcium 65–80% of CEC, magnesium 10–15%, potassium 1–5%, sodium 0-1% and aluminium 0% (NSW Department of Primary Industries 1993). Results from collected samples indicate that soil fertility is low.

Exchangeable sodium percentage

Exchangeable sodium percentage (ESP) is the ratio of exchangeable sodium to the total of exchangeable cations. It is a good indicator of soil structural stability.

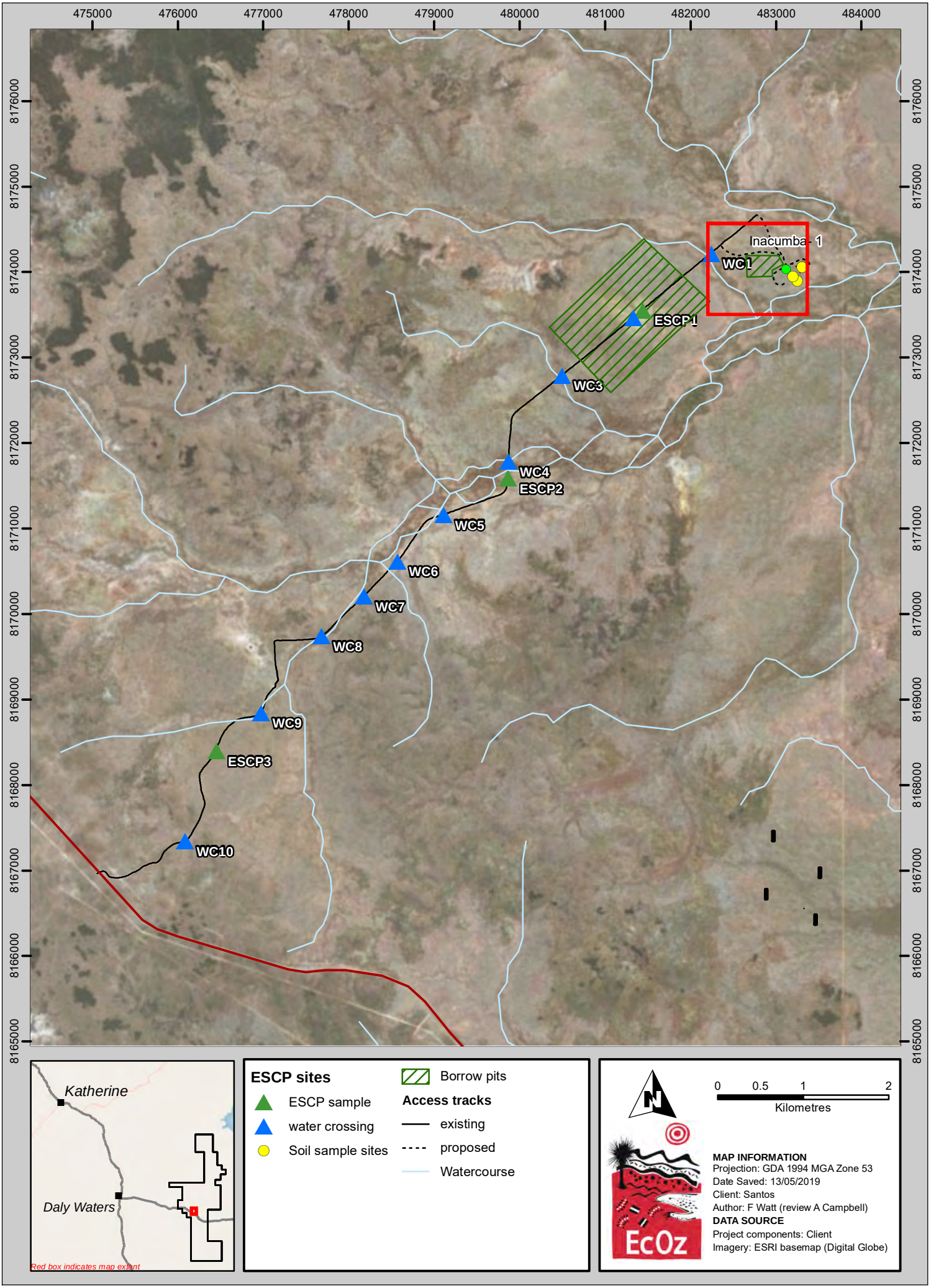
Sandy loam and heavier topsoils with ESP higher than 6 and subsoils with ESP higher than 16 are deemed sodic and likely to have poor structure due to clay dispersion with associated hard-setting, low porosity and high bulk density leading to poor plant root growth and production. (WA Department of Primary Industries and Regional Development 2019). Results from collected samples do not indicate that soils are sodic.

Based on the collected samples and results of analysis, in situ soils do not present constraints in relation to erodibility potential. Soil fertility, however, is typically low which will require consideration during the rehabilitation stages.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19041 - Santos EP161 EMP aspects\01 Project Files\Report maps\Tims report\Figure 3-3. Map of Tanumbirini surface water drainage and soil sampling locations.mxd

Figure 3-3. Map of Tanumbirini surface water drainage and soil sampling locations



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19041 - Santos EP161 EMP aspects\01 Project Files\Report maps\Tims report\Figure 3-4. Map of Inacumba surface water drainage and soil sampling.mxd

Figure 3-4. Map of Inacumba surface water drainage and soil sampling

Table 3-2. Results of soil analysis

Sample ID	Depth (cm)	Colour	Texture	Emerson Class	Exchangeable Cations (meq/100g)					Exchangeable Na %	Particle Size (%)			
					Ca	Mg	K	Na	Cation Exchange Capacity		Clay (<2 µm)	Silt (2-60 µm)	Sand (0.06-2mm)	Gravel (>2mm)
TAN 2 SP	0	Grayish Brown	Sandy Clay	4	24.3	17.4	0.7	<0.1	42.4	0.1	48	24	22	6
	30	Dark Grayish Brown	Sandy Clay	4	6.2	7.6	0.2	0.8	14.9	5.5	56	19	19	6
	60	Grayish Brown	Sandy Clay	4	4.9	8.8	0.2	1.8	15.7	11.5	43	28	20	9
TAN 2 WT	0	Dark Gray	Sandy Clay	3	11.5	9.1	0.8	<0.1	21.4	0.2	21	17	30	32
	30	V Dark Grayish Brown	Sandy Clay	4	13.5	17.0	0.2	0.7	31.4	2.3	39	20	19	22
	60	Dark Gray	Sandy Clay	4	12.8	17.8	0.2	1.2	32.0	3.9	49	17	22	12
TAN 2 DP	0	Grayish Brown	Sandy Clay	4	37.5	13.7	0.8	0.1	52.1	0.2	53	18	15	14
	30	Dark Grayish Brown	Sandy Clay	4	3.0	7.3	<0.2	1.3	11.6	11.0	59	7	12	22
	60	Dark Grayish Brown	Sandy Clay	4	6.3	11.5	0.1	0.3	18.3	1.9	29	9	22	40
INA 2 CP	0	Dark Grayish Brown	Clayey Sand	3	4.8	1.7	0.4	<0.1	6.8	<0.1	15	27	26	32
	30	Dark Grayish Brown	Sandy Loam	3	4.6	2.2	0.4	<0.1	7.2	0.2	33	20	25	22
	60	Dark Yellowish Brown	Sand	8	3.7	2.0	0.3	<0.1	6.1	<0.1	21	7	17	55
INA 2 DP	0	V Dark Grayish Brown	Sandy loam	3	5.6	2.1	0.6	<0.1	8.3	<0.1	13	30	37	20
	30	Brown	Sandy Clay	4	4.8	2.1	0.4	<0.1	7.3	<0.1	36	17	28	19
	60	Brown	Sandy Clay	4	4.3	2.2	0.3	<0.1	6.8	<0.1	42	22	23	13
INA 2 WT	0	Brown	Clayey Sand	3	2.8	2.3	0.6	<0.1	5.8	<0.1	16	18	36	30
	30	Dark Brown	Sandy Clay	4	4.4	4.1	0.1	0.2	8.8	2.2	40	18	27	15
	60	Dark Brown	Sandy Clay	3	5.3	4.8	0.1	0.5	10.6	4.5	43	15	30	12
ESCP 1	0	Olive Brown	Sandy Clay	3	6.2	6.1	0.3	<0.1	12.6	0.7	35	14	29	22
ESCP 2	0	Dark Brown	Medium Clay	4	4.9	4.3	0.5	<0.1	9.8	0.3	35	38	26	1
ESCP 3	0	Dark Grayish Brown	Sandy Clay	3	5.1	5.5	0.4	<0.1	11.0	0.3	26	16	18	40
ESCP 4	0	Dark Grayish Brown	Medium Clay	4	9.6	13.5	0.7	0.1	23.8	0.5	52	28	17	3
ESCP 5	0	Dark Grayish Brown	Sandy Clay	3	5.0	11.0	0.5	0.1	16.7	0.9	37	33	26	4
ESCP 6	0	V Dark Grayish Brown	Sandy Clay	4	5.7	3.8	0.6	<0.1	10.1	0.8	18	28	30	24

4 EROSION HAZARD AND RISK

Inputs and equations used to assess erosion hazard and risk for the project area are detailed in the sections below.

4.1 Erosion hazard

Erosion hazard is assessed using the Revised Universal Soil Loss Equation – RUSLE (IECA 2008). This is commonly used to predict the long term, average, annual soil loss from sheet and rill erosion under specified management conditions. The RUSLE is represented by the following equation:

A = R * K * L * S * P * C, where:

Factor	Description	Value	Comment
A	estimated soil loss (tonnes/ha/yr)	variable	As calculated per catchment
R	rainfall erosivity factor	8,464	Adopted from Darwin Harbour Advisory Committee Research Group for Katherine (Section 4.1.1)
K	soil erodibility factor	0.03	0.03 adopted – sandy loam texture (Section 4.1.2)
LS	slope length/gradient factor	variable	Based on catchment characteristics. (Section 4.1.3)
P	erosion control practice factor	1.3	Construction phase condition (Section 4.1.5)
C	ground cover and management factor	0	Based on proposed surface cover. (Section 4.1.4)

4.1.1 Rainfall erosivity (R–factor)

The rainfall erosivity factor (R-factor) is a measure of the ability of rainfall to cause erosion. It is a product of two components: total energy (E) and maximum 30-minute intensity for each storm (Landcom 2004). The R-factor is an input component in measuring estimated soil loss using the RUSLE calculation. The adopted annual R-factor for the project is 8,464 (Katherine); provided by the Darwin Harbour Advisory Committee Research Group to better reflect the rainfall erosivity of the NT.

4.1.2 Erodibility (K-factor)

The K-factor is a numerical representation of the ability of soils to resist the erosive energy of rain (IECA 2008). Soil texture is the principle component affecting K, but soil structure, organic matter and profile permeability also contribute. A K-factor of 0.03 represents the highest observed soil erodibility based on texture (sandy loam recorded from soil sample INA2 DP 0 - refer Table 3-2); as per IECA 2008 *Table E4 - Default soil erodibility K-factors based on texture class*. Note that all other soil samples had observed textures with lower default K–factors (0.015 – 0.025).

4.1.3 Slope (LS–factor)

The LS-factor describes the combined effect of slope length and slope gradient on soil loss. The access roads will traverse topography up to 8 % slope, with road surface formed with a side slope of 4%. Lease pads will be in areas not exceeding 1 % slope.

4.1.4 Cover and management factor (C–factor)

The cover and management factor is a measure of the level of soil surface protection provided by various groundcovers. It includes proportion of vegetation, rock, hardstand, paving, soil binders, matting and associated non-erodible material. The C-factor for the project will vary depending on stabilisation and management of surfaces exposed by construction and operation. C-factors for various surface are summarised in Table 4-1.

Table 4-1. Adopted C-factors

Surface type	% cover	C-factor
Concrete, bitumen	100	0
Vegetation (highly variable)	25 - 80	0.37 – 0.025
Soil stabiliser (eg. Vital Bon-Matt HR or Bon-Matt RDS (S72))	80	0.025
Rock	80-100	0.025 - 0
95% compacted gravel/soil surface (eg. haul roads/pads)	25	0.37
Bare soil, erosive surface	0 - 20	1 - 0.44

4.1.5 Erosion control practice factor (P–factor)

The P-factor measures the combined effect of all support practices and management variables. It also represents structural methods for controlling erosion (IECA 2008). The nominated P-factor for all areas without permanent stable groundcover is 1.3 (based on the default construction phase condition).

4.1.6 Estimated soil loss

Potential soil loss calculations and associated erosion hazard for defined project areas are provided within Table 4-2. Nominated project components reflect the proposed site layout.

Table 4-2. Soil loss and erosion hazard

Project Areas	Inacumba-1			Tanumbirini-2		
	Road access	Drill pad	Borrow pit	Road access	Drill pad	Borrow pit
Rainfall erosivity (R)	8464	8464	8464	8464	8464	8464
Soil erodibility (K)	0.03	0.03	0.03	0.03	0.03	0.03
Slope length (L)	10	200	200	10	200	200
Slope gradient (S)	8	2	1	8	2	1
Length/gradient (LS)	0.53	0.58	0.25	0.53	0.58	0.25
Erosion control practice (P)	1.3	1.3	1.3	1.3	1.3	1.3
Ground cover in disturbed catchment - %	20	20	5	20	20	5
Ground cover in disturbed catchment (C)	0.37	0.37	0.79	0.37	0.37	0.79
Soil Loss (t/ha/yr)	**65**	**71**	**64**	**65**	**71**	**64**
Soil Loss Class	1	1	1	1	1	1
Erosion Hazard	Very low	Very low	Very low	Very low	Very low	Very low

4.2 Erosion risk

Erosion risk refers to the evaluation of the “risk” of soil erosion when consideration is given to both the degree of erosion and the likelihood of the erosion occurring (IECA 2008). In the absence of a site specific risk assessment procedure, erosion risk rating is determined from the 2 year ARI monthly rainfall depth for Daly Waters Airstrip (Table 4-3).

Erosion risk ratings range from very low for the dry season (Apr – Oct), moderate in the early wet (Nov), then high for the wet season (Dec – Mar).

Table 4-3. Monthly erosion risk rating (based on Daly Waters Airstrip)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall depth (mm)	166.1	180.1	110.4	20.5	6.5	2.9	1.8	0.4	1.9	21.5	49.2	116.1
Rating	High	High	High	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Moderate	High

4.3 Erosion and sediment control requirements

Recommended erosion and sediment control measures are based upon the relationship between erosion hazard (as determined from Table 4-2) and erosion risk (Table 4-3). The reliable and prolonged dry season

(May to September), provides a low risk of erosion from rainfall throughout these months, although wind erosion potential (dust) is significant.

It is essential that erosion and sediment control measures are fully implemented prior to the 1st October in preparation for the wet season. Table 4-4 summarises erosion and sediment control requirements for all stages of civil construction and operation across a full calendar year. Typical measures to be implemented during works are discussed in Section 5. Additional specific design, timing and location are to be provided within Progressive ESCP's and associated engineering drawings.

Table 4-4. Erosion risk and ESC requirements during construction

Erosion Risk Rating	Monthly Rainfall Depth	Period	Erosion & Sediment Control Requirements
Very low	0 to 30mm	Apr - Oct	• ESCs not required for activities which do not disturb groundcover • Unfinished earthworks are suitably stabilised if rainfall is reasonably possible • Sediment control to be installed around areas of erosion risk prior to 1st October (wet season commencement)
Moderate	45+ to 100mm	Nov	• Areas of erosion risk protected within 20 days completion (or cessation) of earthworks or inactivity [1] • Sediment control fully installed & maintained
High	100+ to 225mm	Dec - Mar	• Areas of erosion risk protected within 10 days completion (or cessation) of earthworks or inactivity [1] • Sediment control fully installed & maintained
Notes:	[1] Areas of erosion risk may be protected using the following types of cover: hardstand, soil binder (eg. polymer), placement of mats, blankets (eg. geotextile, jute) or vegetative cover (min 75% for all areas, with min 90% for drainage channels).		

5 EROSION AND SEDIMENT CONTROL MEASURES

Erosion and sediment control measures required during civil construction and operation have been derived based on the site erosion hazard and risk. Conceptual details of the controls are provided in the sections below based on the current level of design detail.

5.1 Progressive ESCP's

As project activities advance, specific up-to-date details on the location and installation of ESC measures will provided within Progressive ESCP's. Typically, this will include the following construction stages/situations where erosion risk rating is assessed as moderate to high (i.e. November – March):

1. Where a new stage of construction/operation works are commenced and/or controls require alteration due to change in work practices (e.g. clear & grub, topsoil strip, bulk earthworks, final stabilisation).
2. Controls require alteration due to change in seasonal conditions (e.g. dry season vs wet season).
3. Installation of road, drainage and waterway crossings.
4. Establishment and operation of borrow pits.
5. A change in the project design occurs that potentially impacts on ESC requirements.
6. The desired outcome (e.g. protection of receiving environments) is not being achieved (as identified from inspections by environmental personnel).

Where required, Progressive ESCP's will be developed with site personnel when specific site conditions can be assessed, and appropriate control measures determined. All Progressive ESCP's are to be consistent with this Primary ESCP, with specific measures in accordance with IECA guidelines, project approvals and associated documentation.

5.2 Drainage control

Drainage controls include measures for the diversion of 'clean' stormwater runoff around and through the site; and the diversion of 'dirty' site stormwater runoff to enable treatment of sediment prior to release offsite, as defined below:

Clean water:

Water that either enters site from an external source and has not been further contaminated by sediment within site; or water that has originated from the site and is of such quality that it does not need to be treated in order to achieve the required water quality standard (IECA 2008). Site clean water constitutes surface runoff from areas of non-erodible cover, including vegetation, hardstand, soil binder, mats or blankets (e.g. geotextile).

Dirty water:

Water not defined as clean, thereby requiring treatment with appropriate controls prior to release from site (IECA 2008).

Temporary drainage controls installed as part of construction will enable management of stormwater within work areas. Drainage controls will perform the following functions:

- Enable diversion of 'clean' up-slope run-on water either around or through project areas at non-scouring velocities.
- Enable collection of 'dirty' runoff generated within project areas and the delivery of this water to an appropriate sediment control measure.
- Minimise the risk of soil erosion caused by site-generated flows within the project, using 'intermediate' flow treatment and release points.
- Control of the flow velocity, volume and location of water passing through the project at drainage line and waterway crossings.

Proposed drainage controls include:

Earth/topsoil bunds

To prevent ingress of upslope clean water into lined sumps within the drill pad area; to prevent ingress of upslope clean water into stockpiled material; to divert site runoff to sediment controls.

Catch drains

For collection and diversion of sheet flow across a slope or around soil disturbances.

Table drains

For collection of road runoff and delivery to mitre drains

Mitre drains

For discharge of road runoff to adjacent areas.

Flow diversion berms

Cross drainage on unsealed roads (ie. whoa-boys / rollover banks)

Rock Check Dams

Velocity control device within concentrated flow channels. Also used as sediment control.

Typical designs are provided within Appendix B and applicable engineering plans.

5.3 Erosion control

Prevention of erosion is the primary approach for the prevention of adverse impacts associated with sedimentation. Project activities are to be undertaken so as to reduce the duration of soil exposure to erosive forces (wind and water), either by holding the soil in place or by shielding it. Measures to be used include a variety of construction practices, structural controls and vegetative measures aimed at managing runoff at a non-erosive velocity, and the protection of disturbed soil surfaces.

The specific measure(s) implemented will be based on seasonal erosion risk and construction considerations. Measures will be documented in the most current Progressive ESCP and based upon IECA guidelines. Proposed controls are listed below:

- Undertaking initial civil works in the dry season months as far as schedule allows.
- Minimise disturbance to existing vegetation as far as practical within the project area. This includes utilising and upgrading existing road infrastructure as far as practical.
- Promptly stabilising exposed areas once civil works are completed.

- Protection of soil surface (temporary and permanent) including placement of hardstand surfaces, use of soil binder, vegetation establishment (including mulch), and protection with mats & blankets (e.g. jute, geotextile) where practical.
- Application of dust suppression by wetting of exposed surfaces (water truck), application of soil binder, and/or application of soil cover.

5.4 Sediment control standards

Sediment control standards are described below and are based upon the soil loss calculations relevant to the project areas (Table 4-2). Typical designs are provided within Appendix B, with more detailed designs to be provided as engineering drawings and applicable site-specific Progressive ESCP's.

Based on soil loss calculations for all work areas (Table 4-2), Type 3 sediment control measures are the minimum standard required (i.e. calculated soil loss <75t/ha/yr); although Type 2 sediment controls may also be adopted. Type 1 controls (e.g. sediment basins) are not specifically required.

Sediment control measures will be installed at site runoff discharge points and integrated with drainage control measures. Suitable sediment controls include:

Rock check dams (RCD)

Velocity control device within concentrated flow channels. Also used as sediment control for coarse sediment control.

Rock Filter Dam (RFD)

RFDs are structures formed by the incorporation of geotextile (e.g. A19 bidum®) to a RFD (40-75mm nominal rock diameter).

Filter Bag/Tube

Filter tubes are geotextile bags through which site runoff is directed to enable filtering and treatment of sediment.

Coir logs

Coir logs are biodegradable tubes filled with densely packed coconut fibre wrapped in coir netting. They can be used as flow diversion berms or to provide sediment control by providing temporary ponding and filtering of site runoff.

Rock berms

Clean rock placed as a perimeter berm to filter sheet flow runoff from site (typical size 40-75 mm).

Sediment fence

Sediment fence may be used in locations where placement of rock berms is not practical (due to access, materials and equipment constraints).

In addition to adopting measures as per IECA Standard Drawings, variations to these may be implemented where it can be demonstrated that they are equally as effective and meet the intent of IECA standards.

Typical sediment control design options are provided within Appendix A.

6 SPECIFIC AREAS AND ACTIVITIES

6.1 Site roads/access

Project access is to be via both existing and new roads from the adjacent Carpentaria Highway (Figure 2-1). Access road design (detailed on Engineering plans provided within Appendix C) include the following:

- 6 – 8 metre carriage width
- formed with 4% side-slope
- minimum 200 mm surface coarse, compacted to 95% MMDD
- drainage (table drains and mitre drains)

Access roads are to be constructed and maintained consistent with the following principles (refer to Appendix B for ESC design detail):

6.1.1 Route selection

- reuse existing access roads wherever possible
- minimise disturbance to soil and vegetation
- minimise the number of watercourse and drainage line crossings
- reduce the catchment area above the road by locating the road along a ridge or as high as possible on side slopes
- locate roads to avoid:
  - steep cross-slopes
  - high erosion hazard soils
  - areas of riparian vegetation
  - perched water tables, swamps, or areas of poor drainage
  - unstable geology, steep topography or rock outcrops.

6.1.2 Design and construction

- Roads are to be graded to a crown, or with crossfall drainage.
- Watercourse crossings and associated approaches are to be protected from erosion.
- Road runoff to be directed to stable outlets (vegetated or rocky areas).
- Upon completion of construction, roads no longer required are to be ripped, topsoiled and revegetated (returned to the pre-disturbance condition).

6.1.3 Cross banks

- Where access road runoff cannot be adequately controlled by cross fall drainage (eg. observation of rills along road surface), construct cross banks consistent with the following:
  - Interval spacing based on contributing catchment area, length of slope and site observations
  - Level outlets, enabling discharge of runoff into undisturbed areas (not directly into watercourses)
  - 300mm consolidated effective height, 2-3m crest width as per Figure 4-2.

- Cross drains (excavated dished drains) may be used for low road grades in place of cross banks

6.1.4 Drainage

- V-shaped drains, with regular discharge to mitre drains, are proposed for upgraded access road sections. This design requires significantly less clearing than alternative profiles (eg. trapezoidal); and suits the construction methodology (ie. grader). Drainage will incorporate check dam controls (eg. rock check dam, filter bag/tube) to provide flow energy dissipation in addition to providing sediment control.
- A regular monitoring regime is to be implemented with additional controls implemented if erosion is identified. This may include additional check dams, application of suitable soil binder, or upgrading of drainage profile (subject to project approvals).

6.2 Watercourse crossings

Road access to both Tanumbirini and Inacumba requires traverse of several ephemeral watercourses, requiring installation of (or upgrade to) stable crossings (refer Figure 3-3 and Figure 3-4).

Engineering plans detailing crossing design (minor, medium and major) are attached as Appendix C. Crossings are to be bed level crossings, constructed flush with the existing invert level of the specific watercourse. Crossings will incorporate a stable rock base, hardstand approaches and flow diversion berms (to shed road runoff), designed to be stable in a 1 in 1 year event.

Crossings are to be constructed in accordance with the following requirements:

- Temporary stockpiling of soil, equipment and materials within watercourses, or on adjacent banks and floodplains, is to be avoided (unless integral to drainage control requirements).
- Where possible, crossings should be constructed at right angles in locations where the stream is straight.
- Access road runoff is to be prevented from directly entering the watercourse by construction of flow diversion banks (rollovers) immediately upslope to divert flow.

6.3 Vegetation clearing

Vegetation clearing associated with exploration activities is to be undertaken in accordance with applicable approvals. Clearing methodology is to incorporate the following:

- Clearing activities to be implemented consistent with the *NTG Land Clearing Guidelines* (DENR 2019)
- Vegetation clearing shall be kept to the minimum amount necessary to allow access and/or approved activities.
- Areas of protected vegetation and significant areas of vegetation are to be retained, and must be clearly identified prior to the commencement of clearing
- Approved areas for native vegetation clearing to be clearly identified.
- Previously cleared areas shall be utilised where possible for laydown and turn around points.
- Disturbance to natural watercourses and associated riparian zones must be limited to the minimum practicable.
- Cleared vegetation is to be retained and reused in site rehabilitation wherever possible.

6.4 Borrow pits

As described in Section 2.3.3, two locations for borrow pits have been identified for Tanumbirini, with an additional two borrow pit areas under investigation for Inacumba. Within identified areas, material will be obtained from extraction areas not exceeding 200 m x 100 m x 3 m deep areas. Borrow pit areas will be managed in accordance with the following:

- Borrow pits linked to main access roads with 300 m access
- Clearing zones and no-go areas to be clearly delineated prior to commencement of clearing activities. Clearing to be within approved areas only.
- Woody vegetation resulting from clearing to be pushed to perimeter of disturbance area.
- Perimeter bunds are to be formed from topsoil overburden (min 0.5m height).These are to be managed to promote the re-establishment of vegetation (eg. incorporate seed bank and organic matter).
- Perimeter bunds are to be located to divert external 'run-on' water from entering work area; and contain internal pit runoff during rainfall events.
- Gravel excavation areas are to be managed so that sideslopes do not exceed 6%.
- Final voids created by gravel extraction are to be designed and located so as to receive internal pit drainage. Areas external to voids to be maintained at slopes < 2% as far as practical.
- Where runoff from within pit cannot be directed internally (ie. to voids, contained by perimeter bunds), Type 2 sediment controls are required at outlet areas to treat runoff prior to discharge. Type 2 controls include rock check dams wrapped in geotextile, mulch berms, sediment bags, coir logs.
- Topsoil is to be stripped in slightly damp condition to reduce dust generation and deterioration in topsoil quality as far as practical. It is acknowledged this may be difficult to achieve during with works commencing in the dry season.
- Topsoil with suitable seed bank should be spread over the exhausted pit areas, to encourage natural regeneration.
- Topsoil is only to be stockpiled when disturbed areas are not available for immediate rehabilitation.
- Gravel stockpiles areas are to be managed to keep stockpile area to a minimum.
- Rehabilitation of gravel pits is to be undertaken progressively.
- Where pits (or sections within pits) are no longer to be used, final rehabilitation is to incorporate:
    - Contouring to ensure drainage of disturbed area is directed to shallow, low-sloped voids (internal).
    - Removal of stockpiled subsoil material.
    - Light contour ripping of reshaped surface.
    - Respreading of topsoil across disturbed surface at 50-100mm depth. Handle topsoil in damp condition and avoid an over-compacted or smooth surface (rough is preferred).
    - Placement of residual organic matter across reshaped landform.
    - Hand seeding/broadcasting of local native grass species is encouraged.
    - Prevention of vehicle traffic entering topsoiled areas.
- For pits which are anticipated to be utilised again in the future, rehabilitation is to incorporate:
    - Contouring to ensure drainage of disturbed area is directed to shallow, low-sloped voids (internal).

- Consolidation of stockpiled subsoil material (to occupy minimal area).
- Light contour ripping of reshaped surface.
- Retention of perimeter bunds (topsoil).

6.5 Topsoil & spoil management

Earthworks are to incorporate the stripping and preservation of topsoil for reuse. The depth of topsoil stripping is dependent upon soil type, however ideally the top 50 mm should be retained separately from other material (contains most of the biological activity and nutrients required for successful rehabilitation).

Topsoil is to be stripped and stockpiled as a bund along the perimeter of the lease pads (inside the cleared vegetation windrow where present). This enables separation of clean and dirty stormwater runoff, in addition to allowing for progressive rehabilitation.

Where additional stockpile sites are required, these areas will be located and constructed as follows:

- Located at least 5 m from existing remnant vegetation, minor flow lines and hazard areas.
- Constructed along the contour as low, flat elongated mounds.
- Topsoil stockpiles are to be constructed less than 2 m in height where available space allows.
- Protected upslope by earth diversion banks to divert run-on water and downslope by either mulch, sediment fence or similar Type 3 sediment control.

6.6 Lease pads

Typical lease pad design is provided within Appendix A. Lease pads are to include the following erosion and sediment control measures:

- Perimeter topsoil berm to divert clean water and enable treatment of site water (1:2 batters; seeded with suitable groundcover species)
- Sediment control at site surface water discharge points (eg. RCD)
- Compacted hardstand surface
- Application of soil binder (polymer) for erosion control and dust suppression where necessary (ie. in event of lack of vegetation cover and/or excessive dust).

Decommissioning of lease pad to be undertaken as per *Project Rehabilitation Management Plan* (refer to Section 7).

6.7 Seismic profiling

Seismic profiling is described within Section 2.3.4. The seismic method uses vibrator trucks to gather data. Due to varying terrain, the line preparation is usually undertaken by a dozer/grader and a light 4WD vehicle, adopting the following methodology to ensure minimal ground disturbance:

- Seismic line will be located to avoid requirement for ground disturbance within riparian areas (eg. watercourse crossings).
- The dozer will ‘walk’ with the blade up in easily traversable terrain, with the marks of the dozer tracks being sufficient for the surveyors and recording crew to follow.
- The dozers will not be utilised in areas where riparian vegetation is present.

Line surveying and spread layout is expected to take two days, the data acquisition is expected to take two to three days, and the retrieval of equipment is expected to take a further two days (Santos 2019).

6.8 Ancillary areas

Ancillary areas include temporary infrastructure required to support the construction program and include construction accommodation camps, site compounds, lay-down areas, turn-around points and above ground facilities.

The erosion and sediment control principles and strategies discussed within this document will equally apply to all ancillary areas. Specific Progressive ESCP's may be developed where additional detail is required for these areas.

7 SITE STABILISATION

Following the completion of project activities, long-term protection of the site from erosion will be provided by appropriate cover, typically vegetation. Santos may request approval to undertake additional exploration activities following the completion of the activities covered under this ESCP (which would require an updated ESCP and applicable approvals). Consequently, permanent stabilisation and rehabilitation will depend on exploration outcomes and the potential for reservoir development. The *Project Rehabilitation Management Plan* will guide permanent stabilisation of project areas.

Photo points (geo-referenced) will be established to provide a balanced representation of the ground condition and various landform and vegetation types encountered, and enable rehabilitation success to be effectively monitored. The process is repeated after the drilling program is completed (i.e. post well completion). The revisit intervals are proposed immediately after rehabilitation works have been completed post decommissioning, following the first wet season, one year after rehabilitation works, and three years after rehabilitation (although the return period is determined by weather/road conditions and current activity in the region). Revisits may also be targeted, with emphasis on sensitive areas and areas potentially subject to erosion such that environmental impact of re-accessing remote locations is minimised in consultation with, and on the advice of, an independent environmental consultant.

Subject to landholder agreement and further exploration activities requiring utilisation of the infrastructure covered under this ESCP, stabilisation of the project area will incorporate the following practices:

- Progressive rehabilitation of disturbed areas (timing of progressive rehabilitation will depend on exploration outcomes and the potential for reservoir development and production).
- Management of topsoil to ensure preservation of its long-term value (refer Section 6.5).
- Removal of all rubbish and waste.
- Removal of above ground infrastructure so that in the event the civils works rehabilitation such as the reprofiling of access roads and lease pads can occur unimpeded.
- Lightly scarifying or rolling all disturbed areas to break up consolidated surfaces.
- Reshaping of drilling sites and access (if required) to ensure lease pads and roads are safe, stable and do not pose a long-term erosion risk.
- Back filling of pits. Pits to be levelled off, mixed with dry stockpiled fill material, and capped with at least 100 mm of topsoil.
- Spreading of stockpiled topsoil material and trees, shrubs and grasses across the lease pad and areas not needed for future monitoring and maintenance.
- Selected plant species for revegetation are appropriate for site conditions and endemic to local vegetation communities.
- Erosion and sediment controls are to remain in place until minimum 70 % self-sustaining groundcover (or groundcover % consistent with adjacent undisturbed areas) is achieved for disturbed areas.

8 MANAGEMENT AND IMPLEMENTATION

This ESCP provides a framework for managing erosion and sediment issues for the exploration activities as detailed within the Project EMP (Santos 2019). The implementation strategy is detailed within the EMP and is consistent with the Santos Management System (SMS).

8.1 Responsibilities

Key personnel roles and responsibilities are detailed within the EMP and summarised in Table 8-1 below.

Table 8-1. Key personnel roles and responsibilities (Santos 2019a)

Role	Responsibility
Santos Field Drilling Supervisor	• To supervise drilling and/ or completions engineering, planning, designing, contracting and supporting operations within Santos, ensuring compliance with SMS. • Ensure adequate resources are in place to meet the requirements within the EMP. • Undertake daily environmental checks as described within the EMP • Ensure incidents and non-conformances are managed as per SMS • Report environmental incidents to the Exploration Manager and ensure reporting and investigations are undertaken. • Ensure records and documents are managed so they are available and retrievable. • Ensure non-conformances identified are communicated, raised in Environment Health and Safety (EHS) Toolbox and corrective actions completed.
NT Exploration Manager	• Ensure overall compliance with the EMP. • Ensure compliance with SMS including the EHS Policy. • Ensure relevant environmental legislative requirements, performance outcomes, performance standards, measurement criteria and requirements in the implementation strategy in this EMP are communicated to the activity key personnel; and audited to inform the EMP Performance Report. • Ensure the EMP Performance Report is prepared and submitted to NT Department of Primary Industry and Resources (DPIR).
Santos Land Access Adviser	• Undertake consultation with relevant persons throughout project planning and implementation. • Document consultation with relevant persons. • Ensure any commitments to relevant persons are undertaken
Santos Environment Lead	• Identify and communicate relevant environmental legislative requirements, Performance Outcomes, Environmental Performance Standards, Measurement Criteria and requirements in the implementation strategy of the EMP (and ESCP) to the NT Exploration Manager and Santos Drilling Field Supervisor. • Develop the environmental component of the activity induction. • Assess any environmentally relevant changes. • Review any non-conformances relevant to Environment Performance to ensure corrective actions are appropriate to prevent recurrence. • Prepare and submit the Environmental Performance Report quarterly to DPIR.

8.2 Training and awareness

Santos staff and contractors undertaking work in the field are required to undertake a two-stage induction process. The general Onshore EHS Induction focuses on hazard identification and sets Santos' expectations for Environment, Health and Safety management for workers at Santos' onshore operational sites. The

general Onshore EHS Induction is supported by an activity specific induction. All field personnel will be required to complete the activity specific induction that will cover the requirements in the Project EMP. At a minimum, the induction will cover:

- Activity description
- Environmental impacts and risks; and associated controls to be implemented
- Roles and responsibilities
- Incident and non-conformance reporting and management

Competency of contractors is assessed as part of the contracting qualification and via the prestart audit. Competencies assessed during the contracting process include:

- EHS Performance
- Internal training and auditing processes
- Existing procedures and training (Santos 2019a)

8.3 ESC installation and maintenance

The installation and maintenance of all ESC measures is to be overseen by a suitably qualified person. Installation is to be consistent with this ESCP and any associated progressive ESCP's.

All required temporary erosion and sediment control measures must be fully operational and maintained in proper working order until permanent stabilisation is achieved. If ESCs are observed to have reduced capacity, damage or insufficient effectiveness, they are to be repaired, improved or substituted as follows:

- Identified soil erosion areas are to be resolved as soon as possible, with additional control measures implemented to prevent recurrence.
- All sediment control devices (other than sediment basins) must be de-silted and made fully operational as soon as reasonable and practicable after runoff-producing rainfall, or if the sediment retention capacity of the device falls below 75% of the design retention capacity (IECA 2008).
- Sediment removed from areas of deposition is to be incorporated within subsoil stockpile areas and/or buried on-site.

Spare materials including geo-fabric, sediment fence material, mulch and rock are to be stored on-site to enable repairs to be conducted within a short timeframe.

8.4 Monitoring & reporting

ESC measures will be inspected in accordance with the SMS, including:

- weekly during dry season work activities
- daily during wet season work activities
- as soon as reasonably practical after receiving significant rainfall events (i.e. >10 mm in 24 hr period).

Visual assessment will be carried out of surface water runoff structures, drainage structures and erosion control structures to ensure they are operating efficiently.

Environmental objectives and targets for erosion and sediment control are to be documented in the EMP. Where monitoring identifies that environmental objectives are not being achieved, corrective actions will be

enacted. Where significant erosion and/or major exceedances of water quality triggers are recorded, a CPESC will be engaged to advise on suitable controls.

8.5 Updates and variations

ESCP's are dynamic documents, typically requiring updating as construction and operational stages progress and site characteristics alter. Any alterations to the implementation of erosion and sediment controls within specific areas will be recorded and outlined in progressive ESCP's. This may include the following scenarios:

- Controls require alteration due to change in work practices or new stage of works is commenced.
- Controls require alteration due to change in seasonal conditions (e.g. dry season vs wet season).
- Changes occur in slope gradients and drainage paths, with their exact form unpredictable before works start.
- A change in the project design occurs that potentially impacts on ESC requirements.
- The desired outcome (e.g. protection of receiving environments) is not being achieved.

9 REFERENCES

Beatty, R (ed.), (1995). *Guidelines for the planning, construction and maintenance of tracks*. NSW Soil Conservation Service. Sydney, NSW.

Bureau of Meteorology (BOM) (2019). *Climate Data Online.* [online] Available at: http://www.bom.gov.au/climate/data/ [Accessed 28 May 2019].

(DECC) NSW Department of Environment & Climate Change (2008). *Managing Urban Stormwater: soils and construction*. *Vol 2C. Unsealed Roads*. DECC. Sydney, NSW.

(DENR) NT Department of Environment and Natural Resources (2008). *Land Systems of the Northern part of the NT (1:250,000)*. Land Resource Assessment Unit, Department of Land Resource Management, Palmerston, Northern Territory

(DENR) NT Department of Environment and Natural Resources (2011). *Land Systems of the Southern part of the NT (1:100,000)*. Land Resource Assessment Unit, Department of Land Resource Management, Palmerston, Northern Territory

(DENR) NT Department of Environment and Natural Resources (2019). Natural Resource Maps. [online] Available at: http://nrmaps.nt.gov.au/nrmaps.html [Accessed 9 May 2019].

(DENR) NT Department of Environment and Natural Resources (2019). *Land Clearing Guidelines*. Land Resource Assessment Unit, Department of Land Resource Management, Palmerston, Northern Territory

Fulton S. and Knapton A. (2015). *Beetaloo Basin Hydrogeological Assessment*. CloudGMS, Australia

International Erosion Control Association (IECA) (2008). *Best Practice Erosion and Sediment Control.* Picton, NSW.

Landcom (2004). *Managing urban stormwater; soils and construction vol. 1, 4th edition*. New South Wales Government.

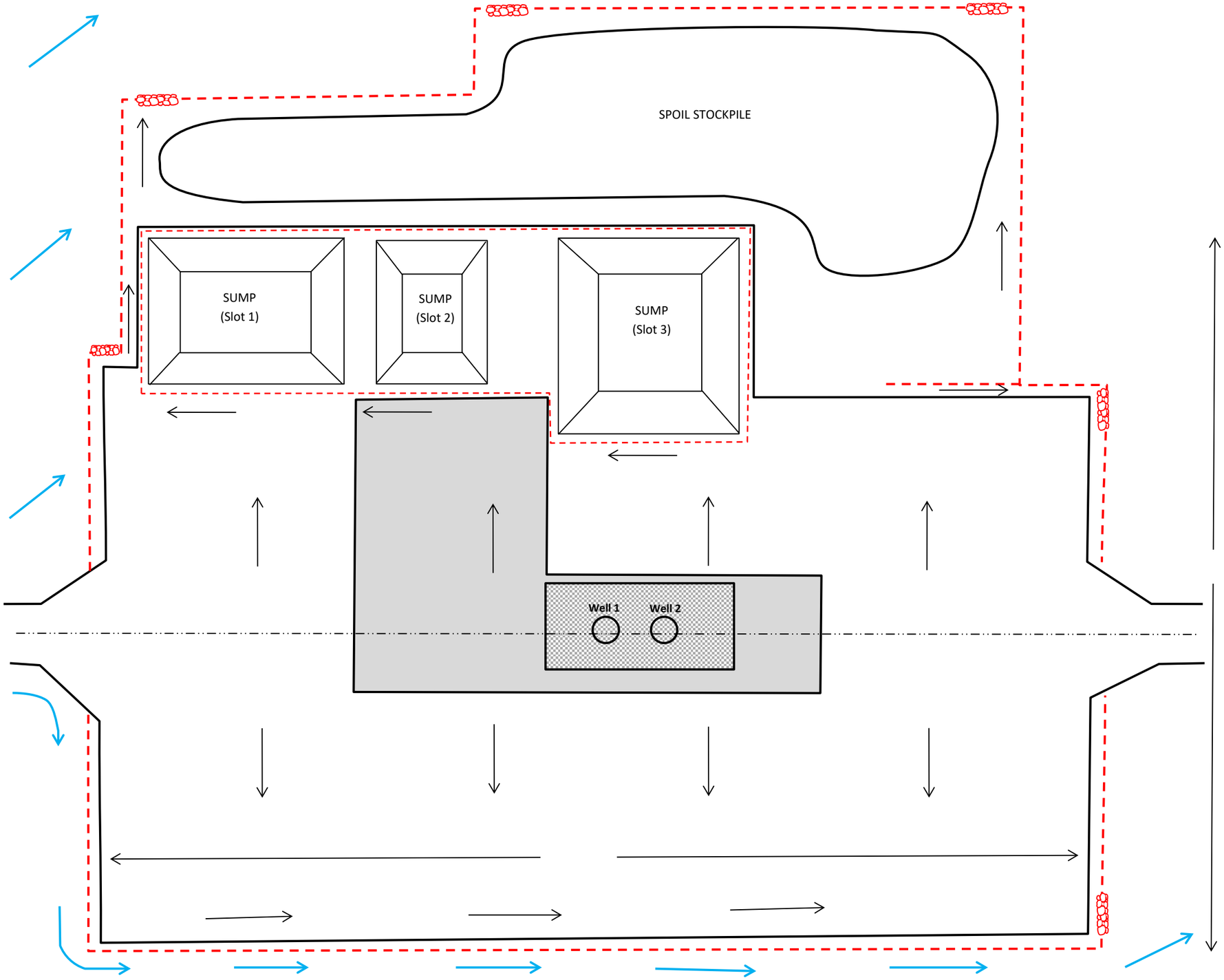
NSW Department of Primary Industries (1993). *Cation Exchange Capacity*. [online] Available at https://www.dpi.nsw.gov.au/agriculture/soils/structure/cec [Accessed 10 May 2019].

Santos (2019). *Environmental Management Plan: McArthur Basin Civil and Seismic Program. NT Exploration Permit (EP) 161*. Rev 3. Santos

Santos (2019a). *Environmental Management Plan: McArthur Basin 2019 Drilling Program. NT Exploration Permit (EP) 161*. Rev 1. Santos

WA Department of Primary Industries and Regional Development (2019). Dispersive (sodic) soils: the science. [online] Available at https://www.agric.wa.gov.au/dispersive-and-sodic-soils/dispersive-sodic-soils-science [Accessed 10 May 2019].

APPENDIX A ESCP - SITE LAYOUT



Notes:

- Lease pad to be fully fenced (stock proof) and entry equipped with gates or grids.
- Lease pad slope not to exceed 1 %.
- Lease pad to be surrounded by perimeter Earth Berm (EB) constructed from topsoil. Min 0.4 m height.
- Perimeter EB can be substituted for Mulch Berm (MB) if mulch is available onsite.
- Perimeter EB to be stabilised (eg. soil binder, jute, vegetation)
- Perimeter EB to incorporate Rock Filter Dams (RFDs) as discharge locations.
- Exact location and dimensions of RFDs to be determined on-site (once detailed site survey undertaken, and lease pad area is pegged out).
- Spoil stockpile to be stabilised from wind and water erosion (eg. soil binder)
- Sumps to be contained by an additional stabilised EB. Min 0.4 m height.
- Sumps to be lined (refer to relevant engineering specification).
- Sump containment volumes: Slot 1 = 2310 m^3; Slot 2 = 572 m^3; Slot 3 = 1160 m^3 (volumes exclude 1 m freeboard)

Legend

→	Clean water
→	Site runoff
▭	Rig pad area
▭	Rig hardstand area
- - -	Earth Berm (topsoil)
○○○	Rock Filter Dam

Revision	Date	Drawn	Approved	Description
1	13/05/19	TE	RH	Sent to client

CERTIFIED PROFESSIONAL IN EROSION AND SEDIMENT CONTROL CPESC®

Tim Elder #4399

EcOz Environmental Consultants

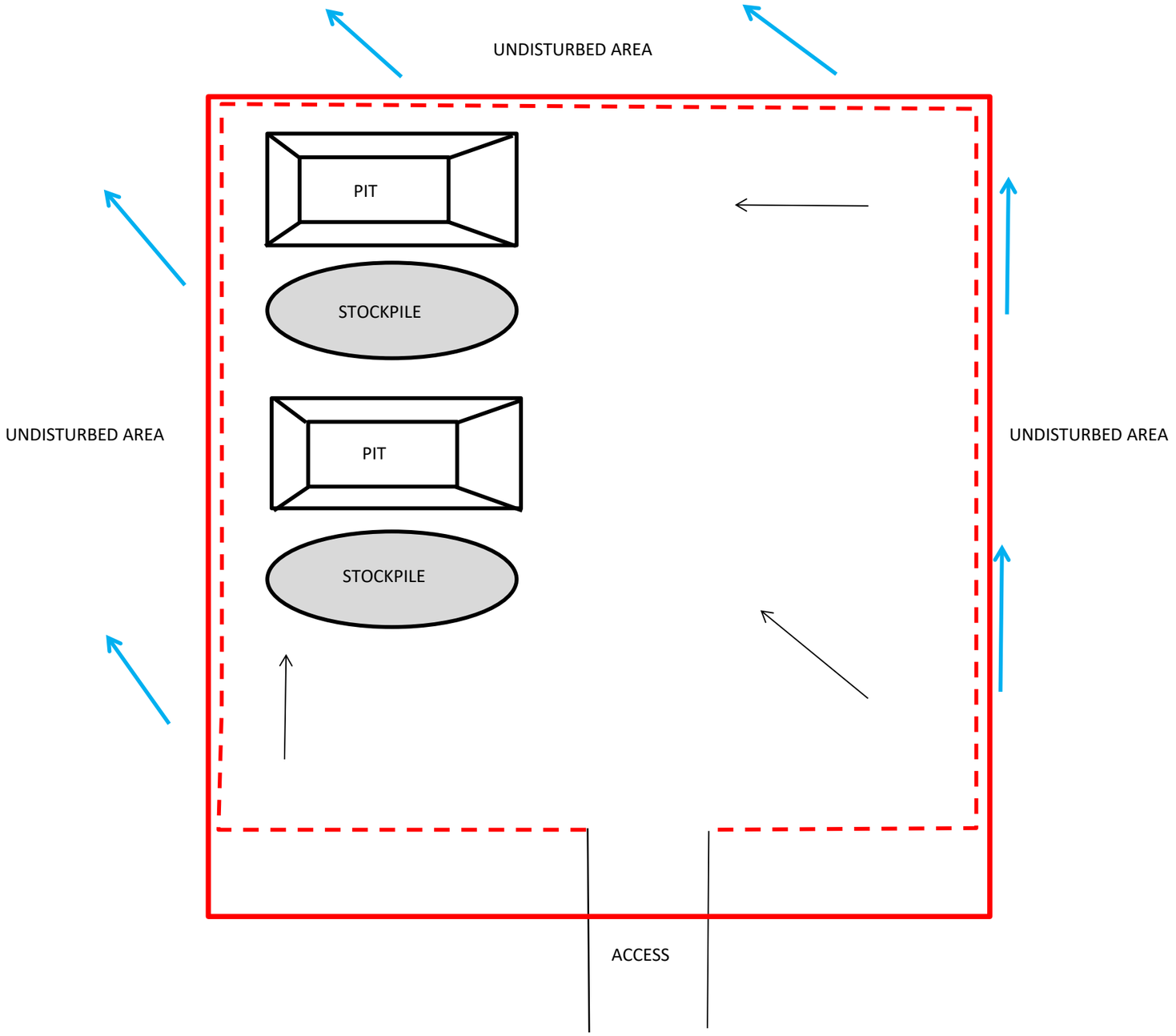
PREPARED FOR: Santos

Exploration Permit 161 - Progressive ESCP001

Lease Pad Area

Period: Dry Season (May - Sep 2019)

NOT TO SCALE	EZ19041-ESCP001-101	REVISION:1



Notes:

- Borrow pit area dimensions to be as per relevant NTG approvals.
- Borrow pit area to be surrounded by perimeter Earth Berm (EB) constructed from topsoil. Min 0.4 m height.
- Perimeter EB can be substituted for Mulch Berm (MB) if mulch is available onsite.
- Perimeter EB to be stabilised (eg. soil binder, jute, vegetation).
- Borrow pit area to contain all site runoff during operation.
- Rehabilitation:
  - internal pit area to be lightly contour ripped prior to respreading topsoil
  - Topsoil perimeter bund to be spread across disturbed surface (50-100mm depth).

Legend

Approval boundary	
Clean water flow	
Site water flow	
Perimeter berm (topsoil)	

Revision	Date	Drawn	Approved	Description
1	13/05/19	TE	RH	Sent to client

CERTIFIED PROFESSIONAL IN EROSION AND SEDIMENT CONTROL CPESC®

Tim Elder #4399

EcOz Environmental Consultants

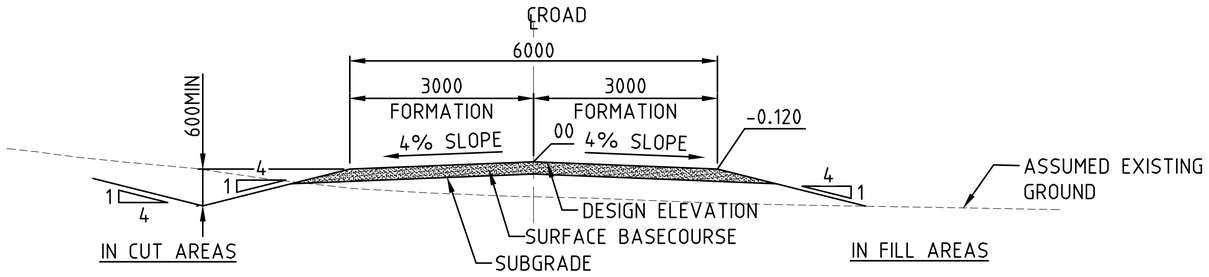
PREPARED FOR: Santos

Exploration Permit 161 - Progressive ESCP001

Borrow Pit Area (Typical layout)

Period: Dry Season (May - Sep 2019)

NOT TO SCALE	EZ19041-ESCP001-102	REVISION:1



PAVEMENT MATERIAL - CLASS C ROAD

SURFACE COURSE	MINIMUM 200mm BEST AVAILABLE LOCAL (CLAY OR CLAYEY SAND) MATERIAL, COMPACTED TO 95% MMDD @ +/- 2% OMC.
SUBGRADE	REMOVE ALL VEGETATION AND COMPACT 200mm SUBGRADE TO 95% MMDD @ +/- 2% OMC.

TYPICAL SECTION - CLASS C ROAD (FOR ELEVATED SECTIONS - OVER AREAS OF SAND OR INUNDATION)

SCALE 1:50

ROAD CONDITION	MIN. VERTICAL CURVE LENGTH (m)	
GRADE CHANGE %	CLASS C	CLASS C 30kph*
1	80	30
2	80	30
3	90	30
4	120	30
5	150	30
6	180	30
7	210	40
8	240	40
9		50
10		55

CLASS C ROADS, SAND DUNE CROSSINGS

ROAD CONDITION	SPEED LIMIT	MIN. HORIZONTAL CURVE LENGTH (m)
CLASS C ROAD	80kph	500

NOTES:

1. THIS DRAWING TO BE READ IN CONJUNCTION WITH ALL THE COMPLETE CONTRACT DOCUMENTS AND SPECIFICATIONS.
2. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
3. FOR SITE PREPARATION, EXCAVATION AND BACKFILL REFER TO PROJECT SPECIFICATION.
4. FOR ROAD CONSTRUCTION REFER TO ROAD WORKS SPECIFICATION 1515-120-S006.
5. SIDE BATTER SLOPES FOR CLASS C ROAD SHALL BE 4 HORIZONTAL TO 1 VERTICAL IN CUT AND FILL.
6. CLEARING, GRUBBING AND STRIPPING OF FULL DEPTH (MIN. 100mm) OF TOPSOIL WITHIN THE ROAD RIGHT OF WAY SHALL BE UNDERTAKEN FOR THE NEW ROAD ALIGNMENTS.
7. FOR CLASS C ROAD, FORMATION ELEVATED TO PROVIDE STABLE RUNNING SURFACE NO PROVISION FOR DRAINAGE.

ROAD CLASSES	C
ROAD WIDTH - METRES	
NORMAL WIDTH	6.0
SAND DUNE CROSSING	8.0
CULVERT/FLOODWAY	8.0

8. TABLE DRAINS. TABLE DRAINS SHALL MITRE AT THE FOLLOWING SPACING.

RECOMMENDED MITRE DRAIN SPACING		
SLOPE		SPACING (m) (MAXIMUM)
%	GRADIENT	
0.5	1 : 200	120
1	1 : 100	120
2	1 : 50	100
3	1 : 33	80
4	1 : 25	60
5	1 : 20	60
6	1 : 17	50
8	1 : 12.5	30

9. MINIMUM INVERT OF TABLE DRAIN TO BE BELOW PAVEMENT SUB-GRADE LEVEL.
10. VERTICAL GRADE ON DUNE APPROACH ROADS TO BE LIMITED TO (10% MAX.) 6% VERTICAL GRADIENT PREFERRED.

1000 0 1000 2000 3000 4000

SCALE 1:50 SCALE IN mm

No	DATE	DRN	CHKD	ENG	Q.A.	PROJ	ACC	DESCRIPTION
C	07/11/17	FYFE		SJM				UPDATED FOR CLIENT REVIEW
B	01/04/16	FYFE		SJM				REVISED FOR REVIEW UNDER MOC-CB-002992
A		KBR		BC				ISSUED FOR CLIENT REVIEW

REVISIONS

DRG No.	SUBJECT

REFERENCE DRAWINGS

DRN: FYFE
DATE:
SCALE: AS SHOWN
CHKD:
ENG: SJM
Q.A.:
PROJ:
ACC:
A.B.N. 80 007 550 923

CIVIL STANDARD DRAWING
TYPICAL ROAD CROSS SECTION
CLASS C ROAD

Santos

DRAWING No. 0001-040-DDR-0004

REV C

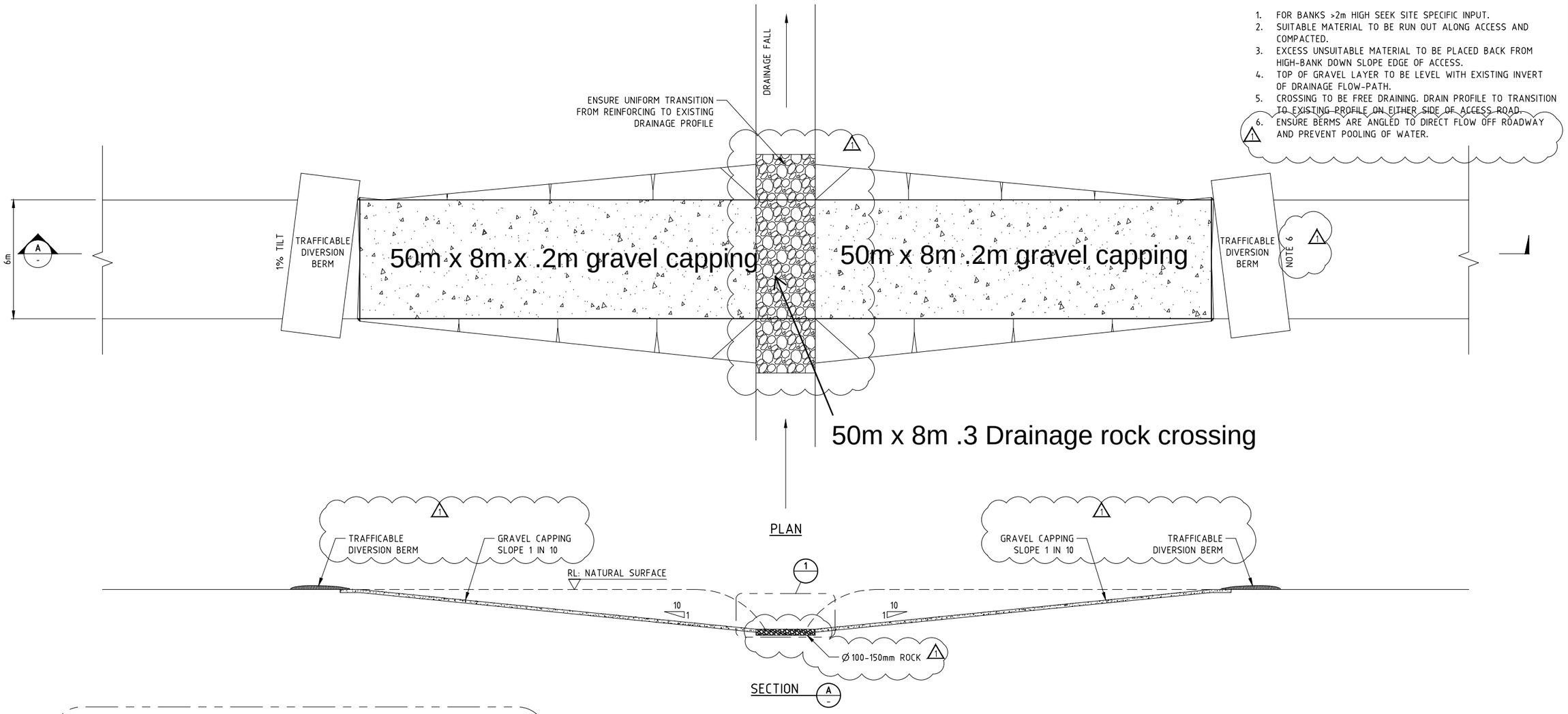
CADFILE No. - aaaa-40-005-1

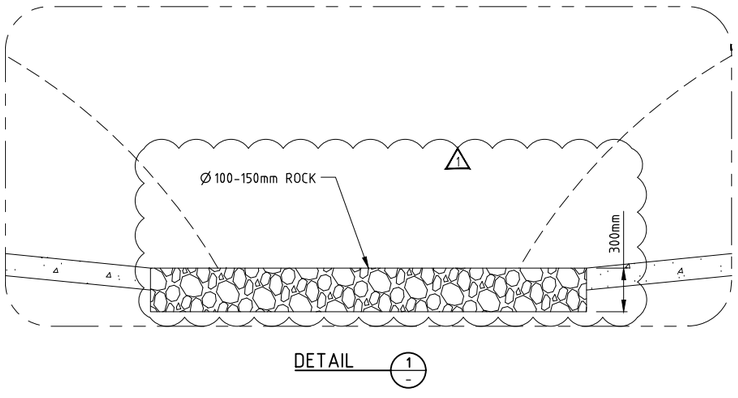
AUTOCAD

TYPICAL ROAD CROSS SECTIONS - CLASS D ROAD (FOR ELEVATED SECTIONS... SHEET 1

NOTES:

1. FOR BANKS >2m HIGH SEEK SITE SPECIFIC INPUT.
2. SUITABLE MATERIAL TO BE RUN OUT ALONG ACCESS AND COMPACTED.
3. EXCESS UNSUITABLE MATERIAL TO BE PLACED BACK FROM HIGH-BANK DOWN SLOPE EDGE OF ACCESS.
4. TOP OF GRAVEL LAYER TO BE LEVEL WITH EXISTING INVERT OF DRAINAGE FLOW-PATH.
5. CROSSING TO BE FREE DRAINING. DRAIN PROFILE TO TRANSITION TO EXISTING PROFILE ON EITHER SIDE OF ACCESS ROAD.
6. ENSURE BERMS ARE ANGLED TO DIRECT FLOW OFF ROADWAY AND PREVENT POOLING OF WATER.





Quantity's

120m3 of 75mm of drainage rock to be imported.

Allow 160m3 to be removed and used as formation or diversion banks if suitable

Import 160m3 of gravel clay, Grade, condition & compact for suitable road surface.

No	DATE	DRN	CHKD	ENG	SANTOS Q.A.	PROJ NO.	RE NAME	RE NO.	RE COMPANY	DESCRIPTION
1	27/6/18	FYF	BR	BR	BR					REPLACED PREV. DWG. WITH MAJOR DRAINAGE CROSSING
0	16/11/17	FYF	BR	BR	BR					ISSUE FOR CONSTRUCTION

REVISIONS

DRG No.	SUBJECT

REFERENCE DRAWINGS

DRN:	FYF	SANTOS Q.A.:	BR
DATE:	16/11/17	PROJ NO.:	
SCALE:	NTS	RE NAME:	
CHKD:	BR	RE NO.:	
ENG:	BR	RE COMPANY:	

A.B.N. 12 131 271 648

AREA 0007 - STANDARD DRAWING

ACCESS ROAD - MAJOR DRAINAGE CROSSING

Santos GLNG

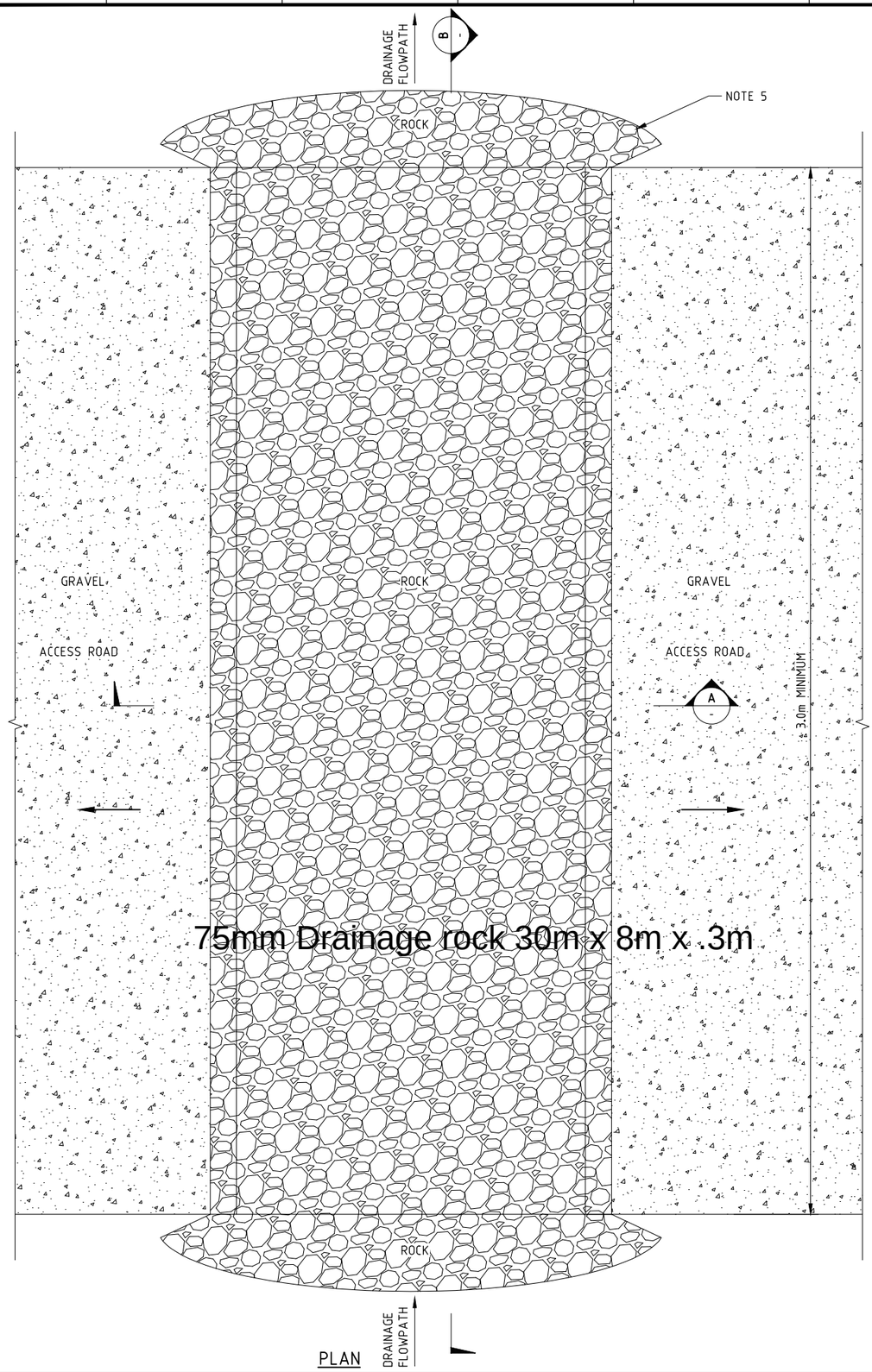
DRAWING No. 0007-040-GAR-0037

REV 1

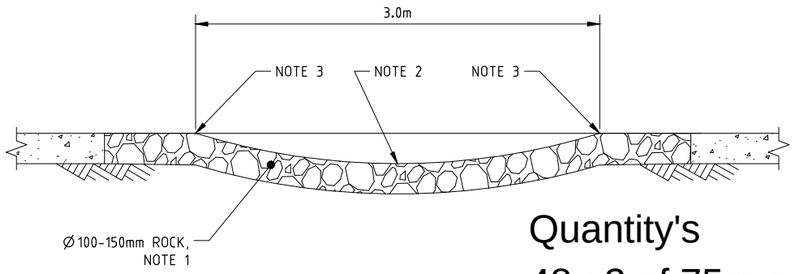
ACCESS ROAD - MAJOR DRAINAGE CROSSING A1SHEET

CADFILE No. -

AUTOCAD



PLAN



SECTION A

NOTES:

1. ~~ALLOW 16m³ IMPORTED DRAINAGE ROCK AND 32m² OF IMPORTED GRAVEL~~.
2. TOP OF ROCK LAYER TO BE LEVEL WITH EXISTING INVERT OF DRAINAGE FLOWPATH.
3. THE TRANSITION FROM ROAD TO INVERT OF DRAINAGE FLOWPATH IS TO BE SUITABLE TO PERMIT RIG ACCESS.
4. CROSSING TO BE FREE DRAINING. DRAIN PROFILE TO TRANSITION TO EXISTING PROFILE ON EITHER SIDE OF ACCESS ROAD.
5. ROCK REINFORCED DRAIN TO FAN OUT TO BOUNDARY OF UNDISTURBED AREA ON THE DOWN-GRADIENT SIDE OF ROAD ONLY.

Quantity's

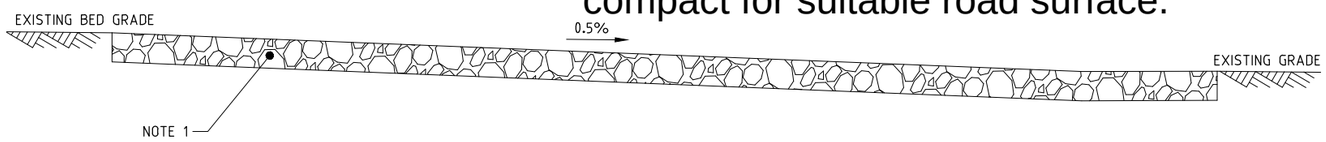
48m3 of 75mm of drainage rock to be imported.

Allow 96m3 to be removed and used as formation

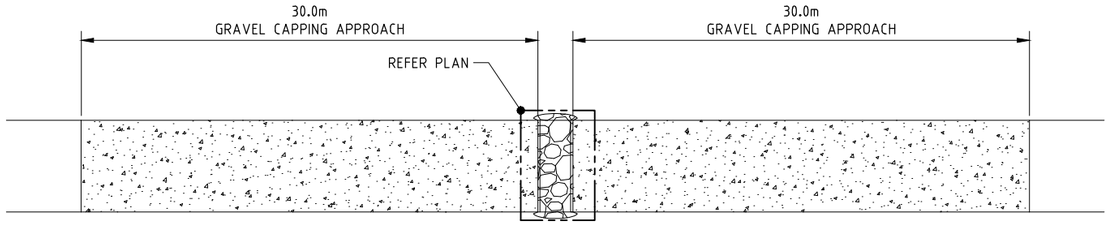
or diversion banks if suitable

Import 96m3 of gravel clay, Grade, condition &

compact for suitable road surface.



SECTION B



APPROACH PLAN

No	DATE	DRN	CHKD	ENG	SANTOS Q.A.	PROJ NO.	RE NAME	RE NO.	RE COMPANY	DESCRIPTION
1	15/5/18	FYF	BR	BR	BR					DRAWING REPLACED WITH NEW MEDIUM DRAINAGE
0	16/11/17	FYF	BR	BR	BR					ISSUED FOR CONSTRUCTION

REVISIONS

DRG No.	SUBJECT

REFERENCE DRAWINGS

DRN:	FYF	SANTOS Q.A.:	BR
DATE:	16/11/17	PROJ NO.:	
SCALE:	NTS	RE NAME:	
CHKD:	BR	RE NO.:	
ENG:	BR	RE COMPANY:	

A.B.N. 12 131 271 648

AREA 0007 - STANDARD DRAWING

ACCESS ROAD MEDIUM DRAINAGE CROSSING

Santos GLNG

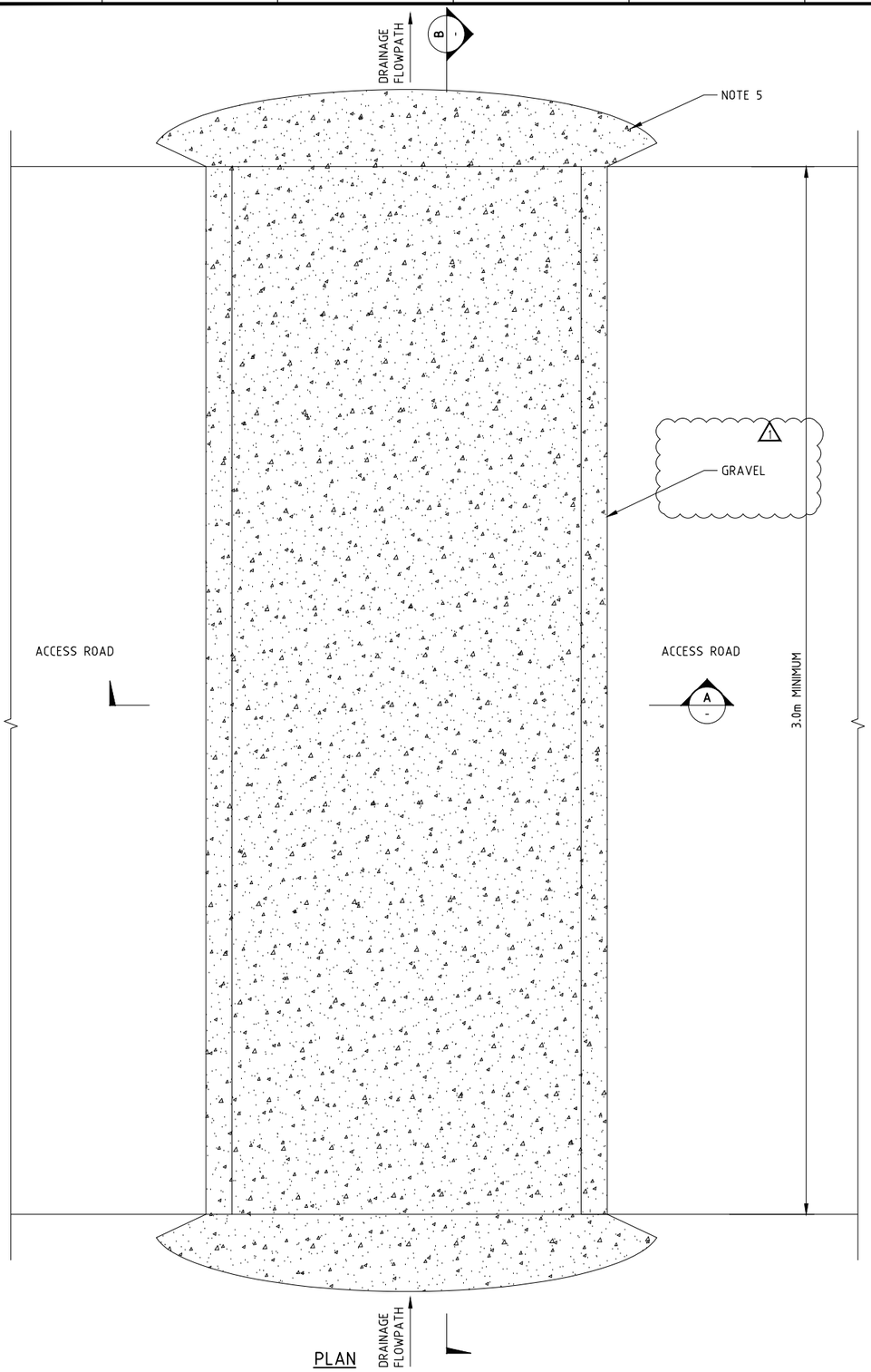
DRAWING No. 0007-040-GAR-0036

REV 1

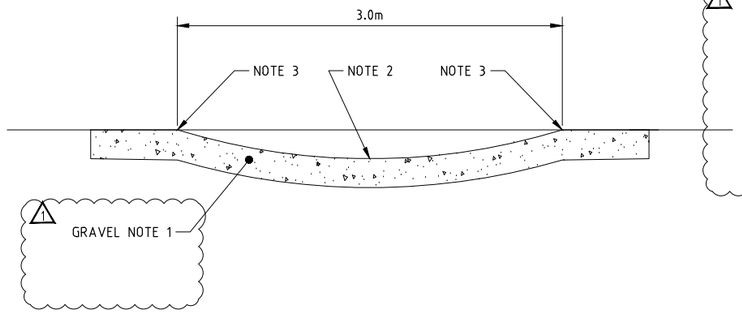
ACCESS ROAD MEDIUM DRAINAGE CROSSING A1SHEET

CADFILE No. -

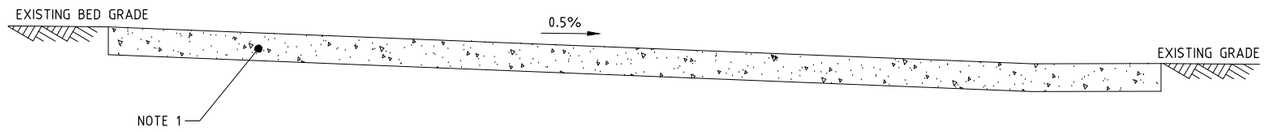
AUTOCAD



PLAN



SECTION A



SECTION B

1 NOTES:

1. ALLOW $16m^3$ IMPORTED GRAVEL.
2. TOP OF GRAVEL LAYER TO BE LEVEL WITH EXISTING INVERT OF DRAINAGE FLOWPATH.
3. THE TRANSITION FROM ROAD TO INVERT OF DRAINAGE FLOWPATH IS TO BE SUITABLE TO PERMIT RIG ACCESS.
4. CROSSING TO BE FREE DRAINING. DRAIN PROFILE TO TRANSITION TO EXISTING PROFILE ON EITHER SIDE OF ACCESS ROAD.
5. GRAVEL REINFORCED DRAIN TO FAN OUT TO BOUNDARY OF UNDISTURBED AREA ON THE DOWN-GRADIENT SIDE OF ROAD ONLY.

No	DATE	DRN	CHKD	ENG	SANTOS Q.A.	PROJ NO.	RE NAME	RE NO.	RE COMPANY	DESCRIPTION
0	27/6/18	FYF	BR	BR	BR					ISSUE FOR CONSTRUCTION

REVISIONS

DRG No.	SUBJECT

REFERENCE DRAWINGS

DRN:	FYF	SANTOS Q.A.:	BR
DATE:	27/6/18	PROJ NO.:	
SCALE:	NTS	RE NAME:	
CHKD:	BR	RE NO.:	
ENG:	BR	RE COMPANY:	

A.B.N. 12 131 271 648

AREA 0007 - STANDARD DRAWING

ACCESS ROAD MINOR DRAINAGE CROSSING

Santos GLNG

DRAWING No. 0007-040-GAR-0035

REV 0

ACCESS ROAD DRAINAGE CROSSING A1SHEET

CADFILE No. -

AUTOCAD

APPENDIX B ESCP - STANDARD DESIGNS

Rock Check Dam (RCD) & Rock Filter Dam (RFD)

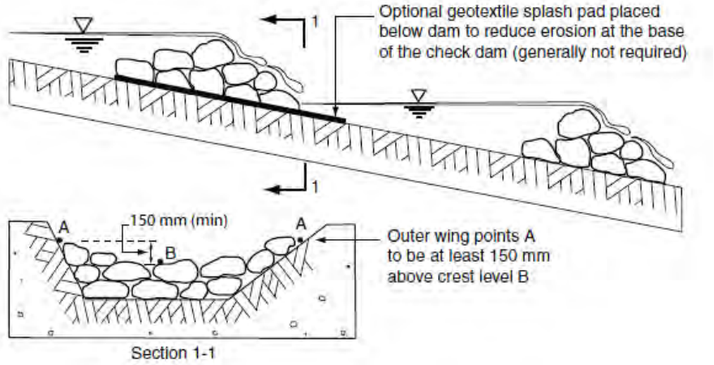
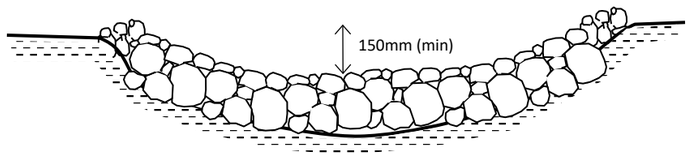


Figure A1. Rock check dams (RCD) (Catchments & Creeks 2009, RCD-01)



Notes:

- Rock to be clean (zero fines), sized 150-300mm (approx.)
- RCD to be extended up the channel bank to prevent outflanking
- RCD to be constructed with 150mm invert
- RCD may be installed as outlet incorporated within mulch berm (MB) and/or earth berm (EB).
- RCD to be covered with geotextile where indicated

Figure A2. Rock check dam (RCD) – typical design

Notes:

- Rock to be clean (zero fines), sized 40-75mm (approx.)
- RFD height 400 mm min
- RFD to be wrapped in geotextile (Bidum®A14 equivalent)
- RFD may be installed as outlet incorporated within mulch berm (MB) and/or earth berm (EB).

Figure A3. Rock filter dam (RFD) – typical design

Mulch Berm (MB) & Earth Berm (EB)

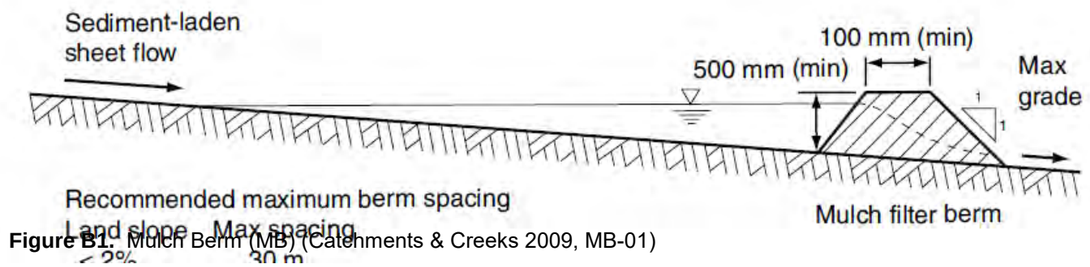


Figure B1. Mulch Berm (MB) (Catchments & Creeks 2009, MB-01)

Notes:

- Design adopted from Catchments & Creeks (2010) *Mulch Filter Berms MB-01*.
- Berm to be located within the property boundary, preferably along the contour, and away from areas of concentrated flow
- Ends of berm to be turned up to minimise risk of flow bypassing around the ends

Notes:

- EB constructed from topsoil whenever material is available
- EB to be protected from erosion (vegetation, soil binder, blankets or matting)

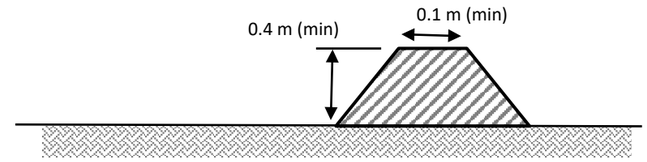


Figure B2. Earth Berm (EB)

Sediment Fence (SF)

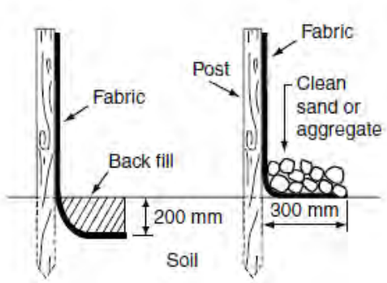


Fig C1. Sediment fence anchoring (Catchments & Creeks 2009, SF-01)

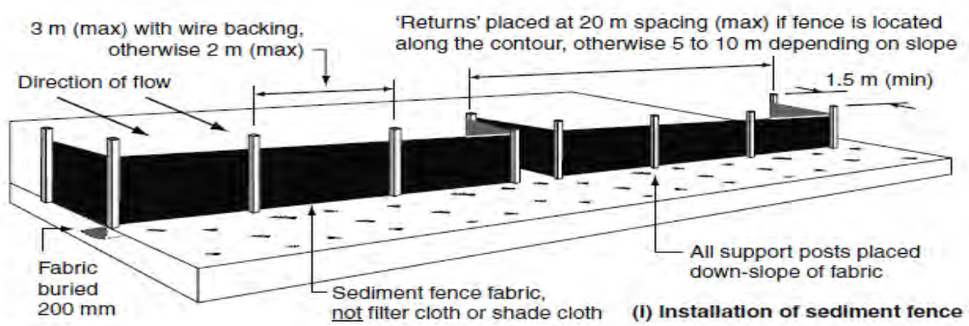


Fig C2. Sediment fence installation (Catchments & Creeks 2009, SF-01)

Revision	Date	Drawn	Approved	Description
1	13/05/19	TE	RH	Sent to client

CPESC® CERTIFIED PROFESSIONAL IN EROSION AND SEDIMENT CONTROL

Tim Elder #4399

EcOz Environmental Consultants

PREPARED FOR: Santos

Exploration Permit 161 - Progressive ESCP001

Typical ESC Designs

(adopted from Catchments & Creeks 2009/10)

NOT TO SCALE	EZ19041-ESCP-110	REVISION:1

Cross drains/banks

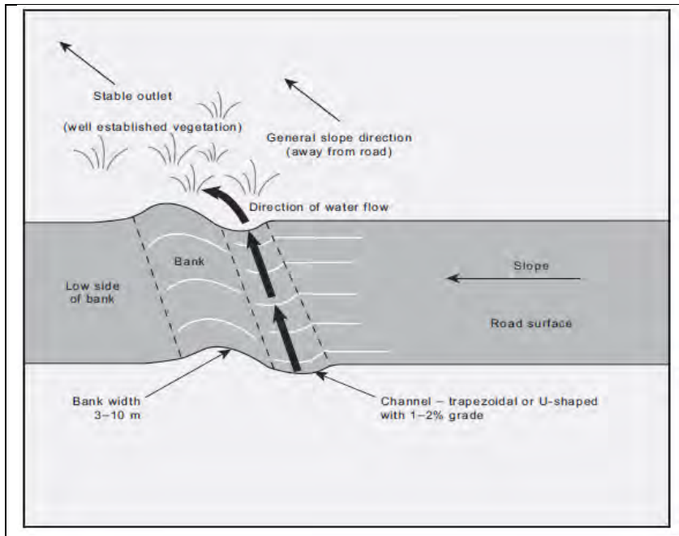


Figure D1. Typical Cross Bank Construction (DECC 2008, modified from Beatty 1995)

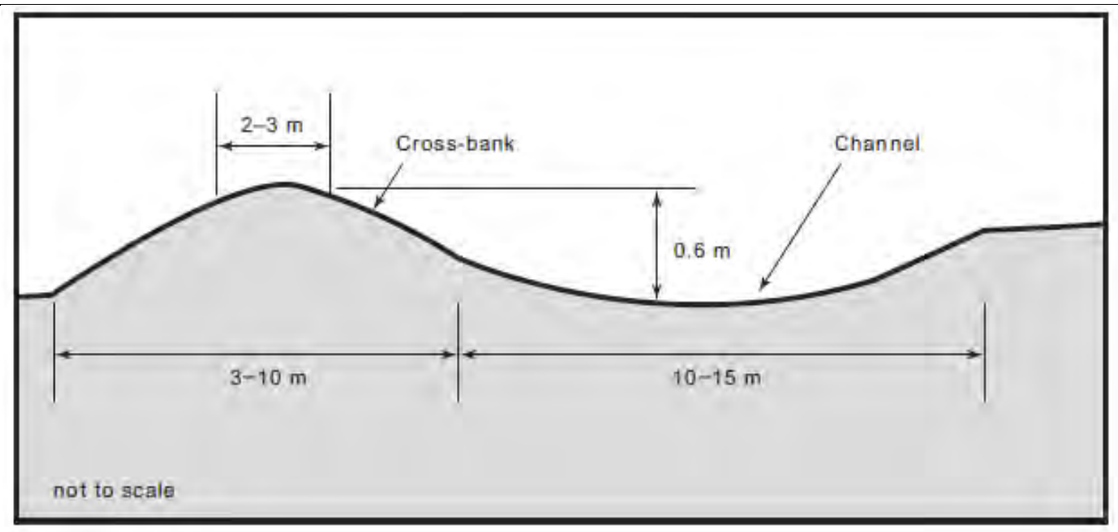


Figure D2. Typical Cross Bank – Cross Section (DECC 2008, modified from Beatty 1995)

Table D1. Maximum distance of water flow along road surfaces

Road grade (%)	Maximum distance (m)
< 2	250
2 - 5	150
6 - 10	100

Revision	Date	Drawn	Approved	Description
1	13/05/19	TE	RH	Sent to client

Tim Elder #4399

EcOz Environmental Consultants

PREPARED FOR: Santos

Exploration Permit 161 - Progressive ESCP001

Typical ESC Designs

(adopted from Catchments & Creeks 2009/10)

NOT TO SCALE	EZ19041-ESCP-110	REVISION:1

APPENDIX C LABORATORY RESULTS

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1911591**	Page	: 1 of 12
Amendment	: **(Preliminary Report)**		
Client	: **ECOZ ENVIRONMENTAL SERVICES**	Laboratory	: Environmental Division Sydney
Contact	: FELICITY WATT	Contact	: Customer Services ES
Address	: PO BOX 381 DARWIN NT, AUSTRALIA 0801	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: 0889811100	Telephone	: +61-2-8784 8555
Project	: EZ19041 Santos Soil Sampling - April 2019	Date Samples Received	: 16-Apr-2019 08:30
Order number	:	Date Analysis Commenced	: 17-Apr-2019
C-O-C number	: 2	Issue Date	: 29-Apr-2019 16:51
Sampler	: FELICITY WATT		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 25		
No. of samples analysed	: 24		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Dian Dao		Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ED048G LOR raised for Alkyl Hexavalent Chromium on various samples due to sample matrix.
- ALS is not NATA accredited for the analysis of Exchangeable Cations on Alkaline Soils when performed under ALS Method ED006.
- EG048G: Poor spike recovery for Alkyl Hexavalent Chromium due to matrix interferences(confirmed by re-analysis).
- EG005: Poor precision was obtained for Barium on sample ES1911591-1. Results have been confirmed by re-extraction and reanalysis.
- EA058 Emerson: V. = Very, D. = Dark, L. = Light, VD. = Very Dark
- ED007 and ED008: When Exchangeable Al is reported from these methods, it should be noted that Rayment & Lyons (2011) suggests Exchange Acidity by 1M KCl - Method 15G1 (ED005) is a more suitable method for the determination of exchange acidity (H+ + Al3+).

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	TAN2 SP 0	TAN2 SP 30	TAN2 SP 60	TAN2 WT 0	TAN2 WT 30
			Client sampling date / time	11-Apr-2019 00:00	11-Apr-2019 00:00	11-Apr-2019 00:00	11-Apr-2019 00:00	11-Apr-2019 00:00
Compound	CAS Number	LOR	Unit	ES1911591-001	ES1911591-002	ES1911591-003	ES1911591-004	ES1911591-005
				Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	12.1	12.8	15.8	9.4	17.9
EA058: Emerson Aggregate Test								
Color (Munsell)	----	-	-	Grayish Brown (10YR 5/2)	Dark Grayish Brown (10YR 4/2)	Grayish Brown (10YR 5/2)	Dark Gray (10YR 4/1)	Very Dark Grayish Brown (2.5Y 3/2)
Texture	----	-	-	Sandy Clay	Sandy Clay	Sandy Clay	Sandy Clay	Sandy Clay
Emerson Class Number	EC/TC	-	-	4	4	4	3	4
ED006: Exchangeable Cations on Alkaline Soils								
Exchangeable Calcium	----	0.2	meq/100g	----	6.2	4.9	----	----
Exchangeable Magnesium	----	0.2	meq/100g	----	7.6	8.8	----	----
Exchangeable Potassium	----	0.2	meq/100g	----	0.2	0.2	----	----
Exchangeable Sodium	----	0.2	meq/100g	----	0.8	1.8	----	----
Cation Exchange Capacity	----	0.2	meq/100g	----	14.9	15.7	----	----
Exchangeable Sodium Percent	----	0.2	%	----	5.5	11.5	----	----
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	----	----	----	11.5	13.5
Exchangeable Magnesium	----	0.1	meq/100g	----	----	----	9.1	17.0
Exchangeable Potassium	----	0.1	meq/100g	----	----	----	0.8	0.2
Exchangeable Sodium	----	0.1	meq/100g	----	----	----	<0.1	0.7
Cation Exchange Capacity	----	0.1	meq/100g	----	----	----	21.4	31.4
Exchangeable Sodium Percent	----	0.1	%	----	----	----	0.2	2.3
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	24.3	----	----	----	----
Exchangeable Magnesium	----	0.1	meq/100g	17.4	----	----	----	----
Exchangeable Potassium	----	0.1	meq/100g	0.7	----	----	----	----
Exchangeable Sodium	----	0.1	meq/100g	<0.1	----	----	----	----
Cation Exchange Capacity	----	0.1	meq/100g	42.4	----	----	----	----
Exchangeable Sodium Percent	----	0.1	%	0.1	----	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	<10	<10	50	<10	<10
EG005(ED093)T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	<5	<5	<5	<5	<5
Barium	7440-39-3	10	mg/kg	390	280	170	180	230
Beryllium	7440-41-7	1	mg/kg	1	<1	1	1	2
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	TAN2 SP 0	TAN2 SP 30	TAN2 SP 60	TAN2 WT 0	TAN2 WT 30
				Client sampling date / time	11-Apr-2019 00:00	11-Apr-2019 00:00	11-Apr-2019 00:00	11-Apr-2019 00:00	11-Apr-2019 00:00
Compound	CAS Number	LOR	Unit		ES1911591-001	ES1911591-002	ES1911591-003	ES1911591-004	ES1911591-005
					Result	Result	Result	Result	Result
EG005(ED093)T: Total Metals by ICP-AES - Continued									
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg		**20**	**14**	**19**	**36**	**20**
Cobalt	7440-48-4	2	mg/kg		**6**	**8**	**6**	**9**	**12**
Copper	7440-50-8	5	mg/kg		**14**	**12**	**12**	**8**	**8**
Lead	7439-92-1	5	mg/kg		**7**	**11**	**8**	**8**	**11**
Manganese	7439-96-5	5	mg/kg		**40**	**81**	**46**	**139**	**148**
Nickel	7440-02-0	2	mg/kg		**11**	**14**	**10**	**11**	**11**
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Strontium	7440-24-6	2	mg/kg		**52**	**48**	**52**	**16**	**32**
Vanadium	7440-62-2	5	mg/kg		**49**	**43**	**43**	**74**	**75**
Zinc	7440-66-6	5	mg/kg		**22**	**24**	**18**	**51**	**13**
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
EG048: Hexavalent Chromium (Alkaline Digest)									
Hexavalent Chromium	18540-29-9	0.5	mg/kg		<5.0	<5.0	<5.0	<5.0	<5.0
EG049: Trivalent Chromium									
Trivalent Chromium	16065-83-1	2	mg/kg		**20**	**14**	**19**	**36**	**20**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	TAN2 WT 60	ESCP1	ESCP2	ESCP3	ESCP4
			Client sampling date / time	11-Apr-2019 00:00	10-Apr-2019 00:00	10-Apr-2019 00:00	10-Apr-2019 00:00	11-Apr-2019 00:00
Compound	CAS Number	LOR	Unit	ES1911591-006	ES1911591-007	ES1911591-008	ES1911591-009	ES1911591-010
				Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	17.8	----	----	----	----
EA058: Emerson Aggregate Test								
Color (Munsell)	----	-	-	Dark Gray (2.5Y 4/1)	Olive Brown (2.5Y 4/3)	Dark Brown (7.5YR 3/4)	Dark Grayish Brown (10YR 4/2)	Dark Grayish Brown (2.5Y 4/2)
Texture	----	-	-	Sandy Clay	Sandy Clay	Medium Clay	Sandy Clay	Medium Clay
Emerson Class Number	EC/TC	-	-	4	3	4	3	4
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	12.8	6.2	4.9	5.1	9.6
Exchangeable Magnesium	----	0.1	meq/100g	17.8	6.1	4.3	5.5	13.5
Exchangeable Potassium	----	0.1	meq/100g	0.2	0.3	0.5	0.4	0.7
Exchangeable Sodium	----	0.1	meq/100g	1.2	<0.1	<0.1	<0.1	0.1
Cation Exchange Capacity	----	0.1	meq/100g	32.0	12.6	9.8	11.0	23.8
Exchangeable Sodium Percent	----	0.1	%	3.9	0.7	0.3	0.3	0.5
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	110	----	----	----	----
EG005(ED093)T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	<5	----	----	----	----
Barium	7440-39-3	10	mg/kg	170	----	----	----	----
Beryllium	7440-41-7	1	mg/kg	1	----	----	----	----
Boron	7440-42-8	50	mg/kg	<50	----	----	----	----
Cadmium	7440-43-9	1	mg/kg	<1	----	----	----	----
Chromium	7440-47-3	2	mg/kg	22	----	----	----	----
Cobalt	7440-48-4	2	mg/kg	11	----	----	----	----
Copper	7440-50-8	5	mg/kg	7	----	----	----	----
Lead	7439-92-1	5	mg/kg	9	----	----	----	----
Manganese	7439-96-5	5	mg/kg	130	----	----	----	----
Nickel	7440-02-0	2	mg/kg	9	----	----	----	----
Selenium	7782-49-2	5	mg/kg	<5	----	----	----	----
Strontium	7440-24-6	2	mg/kg	34	----	----	----	----
Vanadium	7440-62-2	5	mg/kg	60	----	----	----	----
Zinc	7440-66-6	5	mg/kg	10	----	----	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	----	----	----	----
EG048: Hexavalent Chromium (Alkaline Digest)								

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	TAN2 WT 60	ESCP1	ESCP2	ESCP3	ESCP4
				Client sampling date / time	11-Apr-2019 00:00	10-Apr-2019 00:00	10-Apr-2019 00:00	10-Apr-2019 00:00	11-Apr-2019 00:00
Compound	CAS Number	LOR	Unit		ES1911591-006	ES1911591-007	ES1911591-008	ES1911591-009	ES1911591-010
					Result	Result	Result	Result	Result
EG048: Hexavalent Chromium (Alkaline Digest) - Continued									
Hexavalent Chromium	18540-29-9	0.5	mg/kg		<5.0	----	----	----	----
EG049: Trivalent Chromium									
Trivalent Chromium	16065-83-1	2	mg/kg		**22**	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ESCP5	ESCP6	INA1 CP 0	INA1 CP 30	INA1 CP 60
			Client sampling date / time	11-Apr-2019 00:00	11-Apr-2019 00:00	10-Apr-2019 00:00	10-Apr-2019 00:00	10-Apr-2019 00:00
Compound	CAS Number	LOR	Unit	ES1911591-011	ES1911591-012	ES1911591-013	ES1911591-014	ES1911591-015
				Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	----	----	6.7	9.3	7.4
EA058: Emerson Aggregate Test								
Color (Munsell)	----	-	-	Dark Grayish Brown (10YR 4/2)	Very Dark Grayish Brown (2.5Y 3/2)	Dark Grayish Brown (10YR 4/2)	Dark Yellowish Brown (10YR 4/4)	Dark Yellowish Brown (10YR 4/4)
Texture	----	-	-	Sandy Clay	Sandy Clay	Clayey Sand	Sandy Loam	Sand
Emerson Class Number	EC/TC	-	-	3	4	3	3	8
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	5.0	5.7	4.8	4.6	3.7
Exchangeable Magnesium	----	0.1	meq/100g	11.0	3.8	1.7	2.2	2.0
Exchangeable Potassium	----	0.1	meq/100g	0.5	0.6	0.4	0.4	0.3
Exchangeable Sodium	----	0.1	meq/100g	0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	16.7	10.1	6.8	7.2	6.1
Exchangeable Sodium Percent	----	0.1	%	0.9	0.8	<0.1	0.2	<0.1
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	----	----	<10	10	<10
EG005(ED093)T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	----	----	<5	<5	<5
Barium	7440-39-3	10	mg/kg	----	----	50	30	20
Beryllium	7440-41-7	1	mg/kg	----	----	<1	<1	<1
Boron	7440-42-8	50	mg/kg	----	----	<50	<50	<50
Cadmium	7440-43-9	1	mg/kg	----	----	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	----	----	40	55	36
Cobalt	7440-48-4	2	mg/kg	----	----	7	6	5
Copper	7440-50-8	5	mg/kg	----	----	8	10	8
Lead	7439-92-1	5	mg/kg	----	----	10	10	10
Manganese	7439-96-5	5	mg/kg	----	----	346	154	113
Nickel	7440-02-0	2	mg/kg	----	----	6	7	6
Selenium	7782-49-2	5	mg/kg	----	----	<5	<5	<5
Strontium	7440-24-6	2	mg/kg	----	----	14	10	8
Vanadium	7440-62-2	5	mg/kg	----	----	82	110	108
Zinc	7440-66-6	5	mg/kg	----	----	14	6	<5
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	----	----	<0.1	<0.1	<0.1
EG048: Hexavalent Chromium (Alkaline Digest)								

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	ESCP5	ESCP6	INA1 CP 0	INA1 CP 30	INA1 CP 60
				Client sampling date / time	11-Apr-2019 00:00	11-Apr-2019 00:00	10-Apr-2019 00:00	10-Apr-2019 00:00	10-Apr-2019 00:00
Compound	CAS Number	LOR	Unit		ES1911591-011	ES1911591-012	ES1911591-013	ES1911591-014	ES1911591-015
					Result	Result	Result	Result	Result
EG048: Hexavalent Chromium (Alkaline Digest) - Continued									
Hexavalent Chromium	18540-29-9	0.5	mg/kg		----	----	<5.0	<5.0	<2.5
EG049: Trivalent Chromium									
Trivalent Chromium	16065-83-1	2	mg/kg		----	----	**40**	**55**	**36**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	INA1 DP 0	INA1 DP 30	INA1 DP 60	INA1 WT 0	INA1 WT 30
			Client sampling date / time	10-Apr-2019 00:00	10-Apr-2019 00:00	10-Apr-2019 00:00	10-Apr-2019 00:00	10-Apr-2019 00:00
Compound	CAS Number	LOR	Unit	ES1911591-016	ES1911591-017	ES1911591-018	ES1911591-019	ES1911591-020
				Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	6.0	8.9	10.7	5.0	9.3
EA058: Emerson Aggregate Test								
Color (Munsell)	----	-	-	Very Dark Grayish Brown (2.5Y 3/2)	Brown (10YR 4/3)	Brown (10YR 4/3)	Brown (10YR 4/3)	Dark Brown (7.5YR 3/3)
Texture	----	-	-	Sandy Loam	Sandy Clay	Sandy Clay	Clayey Sand	Sandy Clay
Emerson Class Number	EC/TC	-	-	3	4	4	3	4
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	5.6	4.8	4.3	2.8	4.4
Exchangeable Magnesium	----	0.1	meq/100g	2.1	2.1	2.2	2.3	4.1
Exchangeable Potassium	----	0.1	meq/100g	0.6	0.4	0.3	0.6	0.1
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	0.2
Cation Exchange Capacity	----	0.1	meq/100g	8.3	7.3	6.8	5.8	8.8
Exchangeable Sodium Percent	----	0.1	%	<0.1	<0.1	<0.1	<0.1	2.2
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	10	30	<10	<10	10
EG005(ED093)T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	<5	<5	<5	<5	<5
Barium	7440-39-3	10	mg/kg	50	40	40	40	40
Beryllium	7440-41-7	1	mg/kg	<1	<1	<1	<1	<1
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	55	51	56	51	45
Cobalt	7440-48-4	2	mg/kg	7	7	6	5	5
Copper	7440-50-8	5	mg/kg	8	11	11	5	8
Lead	7439-92-1	5	mg/kg	12	12	13	10	11
Manganese	7439-96-5	5	mg/kg	414	240	198	236	99
Nickel	7440-02-0	2	mg/kg	6	7	7	4	5
Selenium	7782-49-2	5	mg/kg	<5	<5	<5	<5	<5
Strontium	7440-24-6	2	mg/kg	15	12	10	9	15
Vanadium	7440-62-2	5	mg/kg	87	119	126	81	115
Zinc	7440-66-6	5	mg/kg	11	6	5	5	<5
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EG048: Hexavalent Chromium (Alkaline Digest)								

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	INA1 DP 0	INA1 DP 30	INA1 DP 60	INA1 WT 0	INA1 WT 30
				Client sampling date / time	10-Apr-2019 00:00	10-Apr-2019 00:00	10-Apr-2019 00:00	10-Apr-2019 00:00	10-Apr-2019 00:00
Compound	CAS Number	LOR	Unit		ES1911591-016	ES1911591-017	ES1911591-018	ES1911591-019	ES1911591-020
					Result	Result	Result	Result	Result
EG048: Hexavalent Chromium (Alkaline Digest) - Continued									
Hexavalent Chromium	18540-29-9	0.5	mg/kg		<5.0	<5.0	<2.5	<5.0	<5.0
EG049: Trivalent Chromium									
Trivalent Chromium	16065-83-1	2	mg/kg		**55**	**51**	**56**	**51**	**45**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	INA1 WT 60	TAN2 DP 0	TAN2 DP 30	TAN2 DP 60	----
			Client sampling date / time	10-Apr-2019 00:00	11-Apr-2019 00:00	11-Apr-2019 00:00	11-Apr-2019 00:00	----
Compound	CAS Number	LOR	Unit	ES1911591-021	ES1911591-022	ES1911591-023	ES1911591-024	--------
				Result	Result	Result	Result	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	10.3	10.6	20.7	15.7	----
EA058: Emerson Aggregate Test								
Color (Munsell)	----	-	-	Dark Brown (10YR 3/3)	Grayish Brown (10YR 5/2)	Dark Grayish Brown (10YR 4/2)	Dark Grayish Brown (10YR 4/2)	----
Texture	----	-	-	Sandy Clay	Sandy Clay	Sandy Clay	Sandy Clay	----
Emerson Class Number	EC/TC	-	-	3	4	4	4	----
ED006: Exchangeable Cations on Alkaline Soils								
Exchangeable Calcium	----	0.2	meq/100g	----	----	3.0	----	----
Exchangeable Magnesium	----	0.2	meq/100g	----	----	7.3	----	----
Exchangeable Potassium	----	0.2	meq/100g	----	----	<0.2	----	----
Exchangeable Sodium	----	0.2	meq/100g	----	----	1.3	----	----
Cation Exchange Capacity	----	0.2	meq/100g	----	----	11.6	----	----
Exchangeable Sodium Percent	----	0.2	%	----	----	11.0	----	----
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	5.3	37.5	----	----	----
Exchangeable Magnesium	----	0.1	meq/100g	4.8	13.7	----	----	----
Exchangeable Potassium	----	0.1	meq/100g	0.1	0.8	----	----	----
Exchangeable Sodium	----	0.1	meq/100g	0.5	0.1	----	----	----
Cation Exchange Capacity	----	0.1	meq/100g	10.6	52.1	----	----	----
Exchangeable Sodium Percent	----	0.1	%	4.5	0.2	----	----	----
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	----	----	----	6.3	----
Exchangeable Magnesium	----	0.1	meq/100g	----	----	----	11.5	----
Exchangeable Potassium	----	0.1	meq/100g	----	----	----	0.1	----
Exchangeable Sodium	----	0.1	meq/100g	----	----	----	0.3	----
Cation Exchange Capacity	----	0.1	meq/100g	----	----	----	18.3	----
Exchangeable Sodium Percent	----	0.1	%	----	----	----	1.9	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	370	<10	40	60	----
EG005(ED093)T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	<5	<5	<5	<5	----
Barium	7440-39-3	10	mg/kg	40	220	140	80	----
Beryllium	7440-41-7	1	mg/kg	<1	1	2	1	----
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	INA1 WT 60	TAN2 DP 0	TAN2 DP 30	TAN2 DP 60	----
				Client sampling date / time	10-Apr-2019 00:00	11-Apr-2019 00:00	11-Apr-2019 00:00	11-Apr-2019 00:00	----
Compound	CAS Number	LOR	Unit		ES1911591-021	ES1911591-022	ES1911591-023	ES1911591-024	--------
					Result	Result	Result	Result	----
EG005(ED093)T: Total Metals by ICP-AES - Continued									
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	----
Chromium	7440-47-3	2	mg/kg		**57**	**21**	**20**	**37**	----
Cobalt	7440-48-4	2	mg/kg		**5**	**9**	**10**	**6**	----
Copper	7440-50-8	5	mg/kg		**9**	**16**	**13**	**8**	----
Lead	7439-92-1	5	mg/kg		**11**	**9**	**8**	**10**	----
Manganese	7439-96-5	5	mg/kg		**117**	**84**	**51**	**52**	----
Nickel	7440-02-0	2	mg/kg		**7**	**14**	**16**	**10**	----
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	----
Strontium	7440-24-6	2	mg/kg		**22**	**56**	**55**	**22**	----
Vanadium	7440-62-2	5	mg/kg		**131**	**62**	**62**	**86**	----
Zinc	7440-66-6	5	mg/kg		<5	**20**	**16**	**10**	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	----
EG048: Hexavalent Chromium (Alkaline Digest)									
Hexavalent Chromium	18540-29-9	0.5	mg/kg		<5.0	<5.0	<2.5	<5.0	----
EG049: Trivalent Chromium									
Trivalent Chromium	16065-83-1	2	mg/kg		**57**	**21**	**20**	**37**	----

Certificate of Analysis

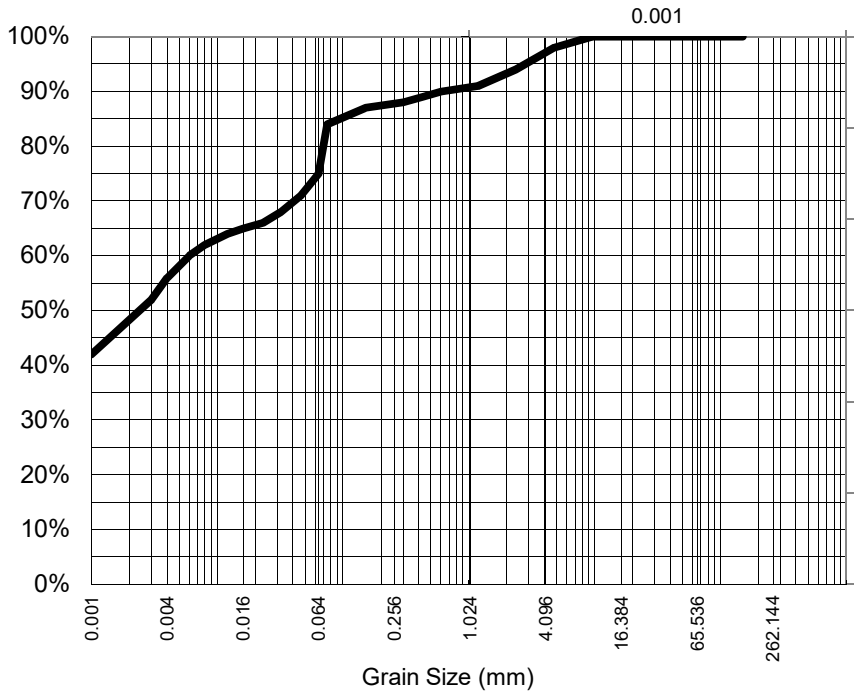
ALS Laboratory Group Pty Ltd
5/585 Maitland Road
Mayfield West, NSW 2304
pH 02 4014 2500
fax 02 4968 0349
samples.newcastle@alsenviro.com

ALS Environmental

Newcastle, NSW

CLIENT:	FELICITY WATT	**DATE REPORTED:**	2-May-2019
COMPANY:	ECOZ ENVIRONMENTAL SERVICES	**DATE RECEIVED:**	16-Apr-2019
ADDRESS:	Po Box 381 Darwin NT, Australia	**REPORT NO:**	ES1911591-001 / PSD
PROJECT:	EZ19041 Santos Soil Sampling - April 2019	**SAMPLE ID:**	TAN2 SP 0

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	98%
2.36	94%
1.18	91%
0.600	90%
0.425	89%
0.300	88%
0.150	87%
0.075	84%
Particle Size (microns)	
46	71%
32	68%
23	66%
16	65%
12	64%
8	62%
6	60%
4	56%
1	42%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	<0.006

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:		**Analysed:**	29-Apr-19
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	FINES, SAND, GRAVEL	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3		
Soil Particle Density (<2.36mm)	2.59		

NATA Accreditation: 825 Site: Newcastle
This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced, except in full.

NATA
WORLD RECOGNISED ACCREDITATION

Dianne Blane
Laboratory Coordinator
Authorised Signatory

Certificate of Analysis

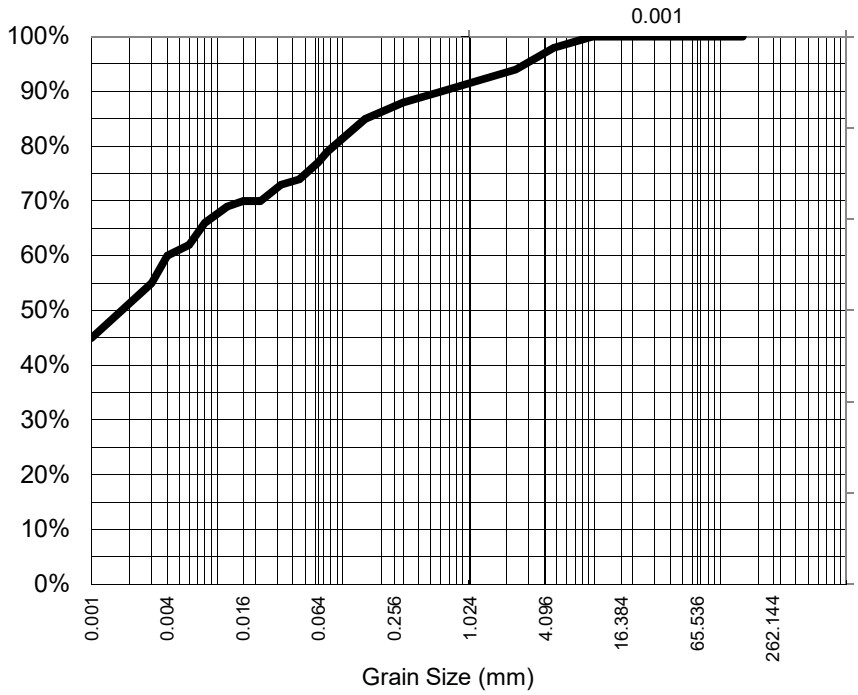
ALS Laboratory Group Pty Ltd
5/585 Maitland Road
Mayfield West, NSW 2304
pH 02 4014 2500
fax 02 4968 0349
samples.newcastle@alsenviro.com

ALS Environmental

Newcastle, NSW

CLIENT:	FELICITY WATT	**DATE REPORTED:**	2-May-2019
COMPANY:	ECOZ ENVIRONMENTAL SERVICES	**DATE RECEIVED:**	16-Apr-2019
ADDRESS:	Po Box 381 Darwin NT, Australia	**REPORT NO:**	ES1911591-002 / PSD
PROJECT:	EZ19041 Santos Soil Sampling - April 2019	**SAMPLE ID:**	TAN2 SP 30

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	98%
2.36	94%
1.18	92%
0.600	90%
0.425	89%
0.300	88%
0.150	85%
0.075	79%
Particle Size (microns)	
45	74%
32	73%
22	70%
16	70%
12	69%
8	66%
6	62%
4	60%
1	45%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	<0.006

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:		**Analysed:**	29-Apr-19
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	FINES, SAND, GRAVEL	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3		
Soil Particle Density (<2.36mm)	2.6		

NATA Accreditation: 825 Site: Newcastle
This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced, except in full.

NATA
WORLD RECOGNISED ACCREDITATION

Dianne Blane
Laboratory Coordinator
Authorised Signatory

Certificate of Analysis

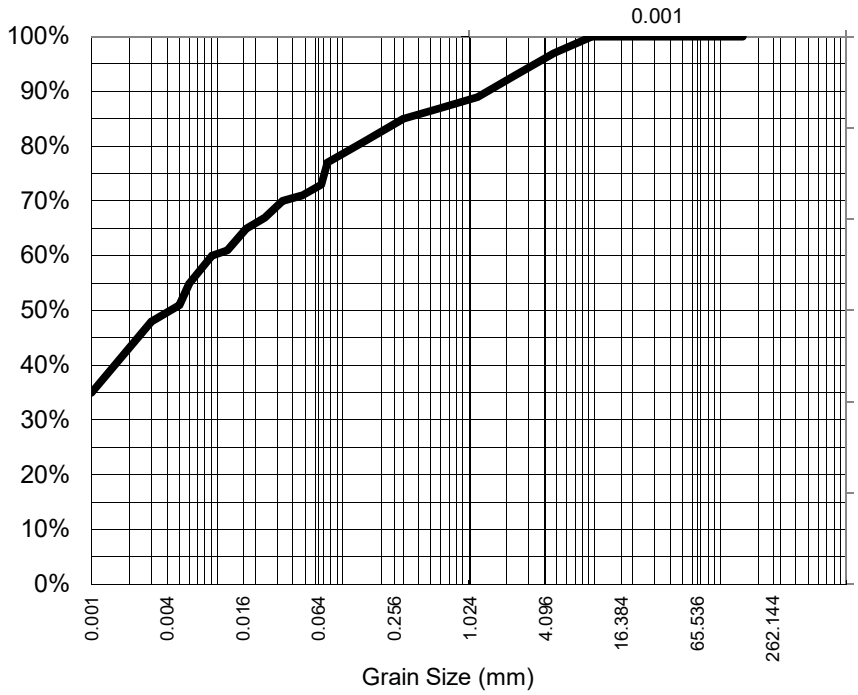
ALS Laboratory Group Pty Ltd
5/585 Maitland Road
Mayfield West, NSW 2304
pH 02 4014 2500
fax 02 4968 0349
samples.newcastle@alsenviro.com

ALS Environmental

Newcastle, NSW

CLIENT:	FELICITY WATT	**DATE REPORTED:**	2-May-2019
COMPANY:	ECOZ ENVIRONMENTAL SERVICES	**DATE RECEIVED:**	16-Apr-2019
ADDRESS:	Po Box 381 Darwin NT, Australia	**REPORT NO:**	ES1911591-003 / PSD
PROJECT:	EZ19041 Santos Soil Sampling - April 2019	**SAMPLE ID:**	TAN2 SP 60

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	97%
2.36	93%
1.18	89%
0.600	87%
0.425	86%
0.300	85%
0.150	81%
0.075	77%
Particle Size (microns)	
47	71%
33	70%
24	67%
17	65%
12	61%
9	60%
6	55%
5	51%
1	35%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	<0.006

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Analysed: 29-Apr-19

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: FINES, SAND, GRAVEL

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.49

NATA Accreditation: 825 Site: Newcastle
This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced, except in full.

NATA
WORLD RECOGNISED ACCREDITATION

Dianne Blane
Laboratory Coordinator
Authorised Signatory

Certificate of Analysis

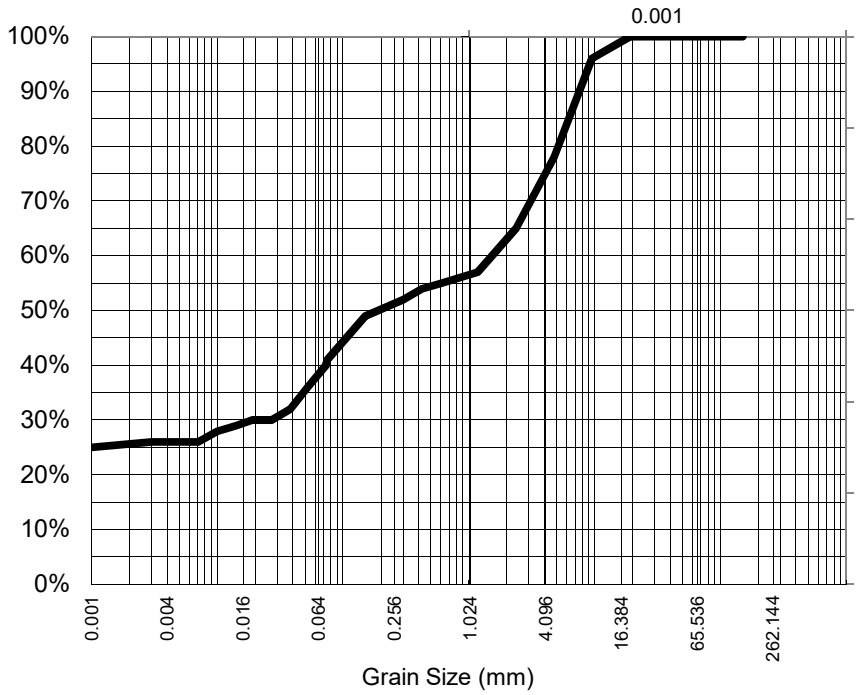
ALS Laboratory Group Pty Ltd
5/585 Maitland Road
Mayfield West, NSW 2304
pH 02 4014 2500
fax 02 4968 0349
samples.newcastle@alsenviro.com

ALS Environmental

Newcastle, NSW

CLIENT:	FELICITY WATT	**DATE REPORTED:**	2-May-2019
COMPANY:	ECOZ ENVIRONMENTAL SERVICES	**DATE RECEIVED:**	16-Apr-2019
ADDRESS:	Po Box 381 Darwin NT, Australia	**REPORT NO:**	ES1911591-004 / PSD
PROJECT:	EZ19041 Santos Soil Sampling - April 2019	**SAMPLE ID:**	TAN2 WT 0

Particle Size Distribution



Particle Size (mm)	% Passing
19.0	100%
9.50	96%
4.75	78%
2.36	65%
1.18	57%
0.600	55%
0.425	54%
0.300	52%
0.150	49%
0.075	41%
Particle Size (microns)	
52	36%
38	32%
27	30%
19	30%
14	29%
10	28%
7	26%
5	26%
1	25%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	0.200

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Analysed: 29-Apr-19

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: FINES, SAND, GRAVEL

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.54

NATA Accreditation: 825 Site: Newcastle
This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced, except in full.

NATA
WORLD RECOGNISED ACCREDITATION

Dianne Blane
Laboratory Coordinator
Authorised Signatory

Certificate of Analysis

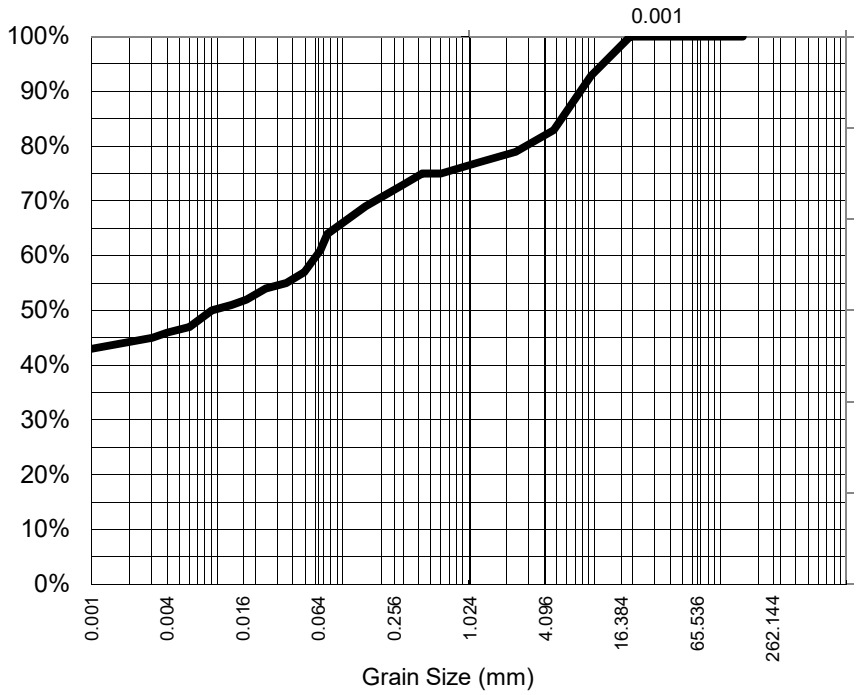
ALS Laboratory Group Pty Ltd
5/585 Maitland Road
Mayfield West, NSW 2304
pH 02 4014 2500
fax 02 4968 0349
samples.newcastle@alsenviro.com

ALS Environmental

Newcastle, NSW

CLIENT:	FELICITY WATT	**DATE REPORTED:**	2-May-2019
COMPANY:	ECOZ ENVIRONMENTAL SERVICES	**DATE RECEIVED:**	16-Apr-2019
ADDRESS:	Po Box 381 Darwin NT, Australia	**REPORT NO:**	ES1911591-005 / PSD
PROJECT:	EZ19041 Santos Soil Sampling - April 2019	**SAMPLE ID:**	TAN2 WT 30

Particle Size Distribution



Particle Size (mm)	% Passing
19.0	100%
9.50	93%
4.75	83%
2.36	79%
1.18	77%
0.600	75%
0.425	75%
0.300	73%
0.150	69%
0.075	64%
Particle Size (microns)	
49	57%
35	55%
24	54%
17	52%
13	51%
9	50%
6	47%
4	46%
1	43%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	0.009

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:		**Analysed:**	29-Apr-19
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	FINES, SAND, GRAVEL	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3		
Soil Particle Density (<2.36mm)	2.53		

NATA Accreditation: 825 Site: Newcastle
This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced, except in full.

Dianne Blane
Laboratory Coordinator
Authorised Signatory

Certificate of Analysis

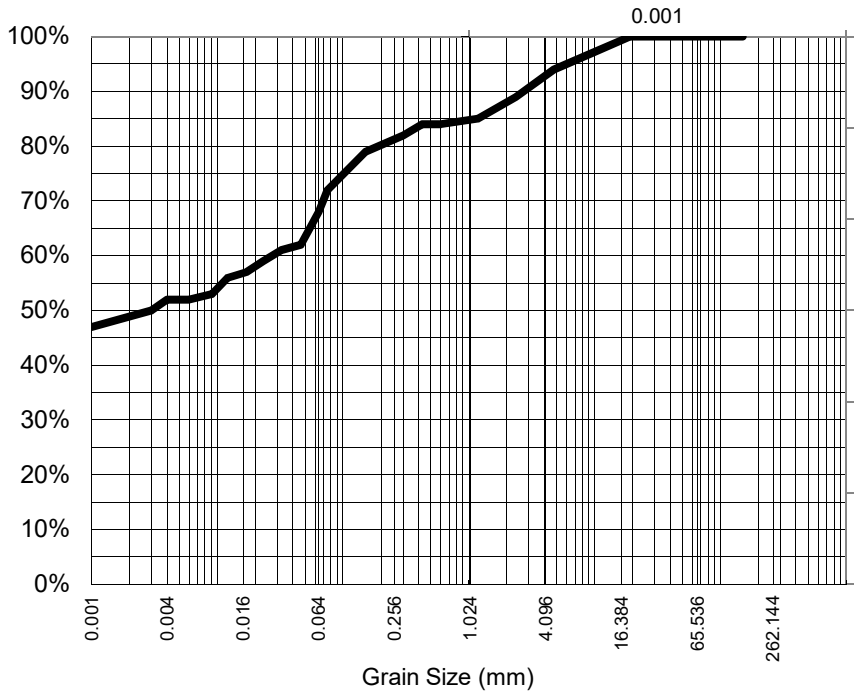
ALS Laboratory Group Pty Ltd
5/585 Maitland Road
Mayfield West, NSW 2304
pH 02 4014 2500
fax 02 4968 0349
samples.newcastle@alsenviro.com

ALS Environmental

Newcastle, NSW

CLIENT:	FELICITY WATT	**DATE REPORTED:**	2-May-2019
COMPANY:	ECOZ ENVIRONMENTAL SERVICES	**DATE RECEIVED:**	16-Apr-2019
ADDRESS:	Po Box 381 Darwin NT, Australia	**REPORT NO:**	ES1911591-006 / PSD
PROJECT:	EZ19041 Santos Soil Sampling - April 2019	**SAMPLE ID:**	TAN2 WT 60

Particle Size Distribution



Particle Size (mm)	% Passing
19.0	100%
9.50	97%
4.75	94%
2.36	89%
1.18	85%
0.600	84%
0.425	84%
0.300	82%
0.150	79%
0.075	72%
Particle Size (microns)	
46	62%
32	61%
23	59%
17	57%
12	56%
9	53%
6	52%
4	52%
1	47%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	<0.006

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Analysed: 29-Apr-19

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: FINES, SAND, GRAVEL

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.59

NATA Accreditation: 825 Site: Newcastle
This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced, except in full.

NATA
WORLD RECOGNISED ACCREDITATION

Dianne Blane
Laboratory Coordinator
Authorised Signatory

Certificate of Analysis

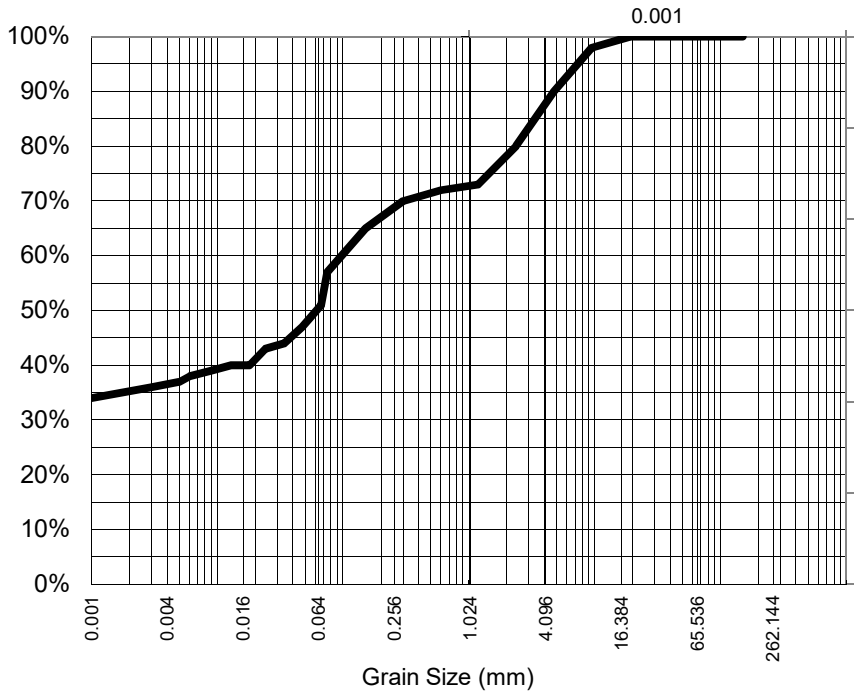
ALS Laboratory Group Pty Ltd
5/585 Maitland Road
Mayfield West, NSW 2304
pH 02 4014 2500
fax 02 4968 0349
samples.newcastle@alsenviro.com

ALS Environmental

Newcastle, NSW

CLIENT:	FELICITY WATT	**DATE REPORTED:**	2-May-2019
COMPANY:	ECOZ ENVIRONMENTAL SERVICES	**DATE RECEIVED:**	16-Apr-2019
ADDRESS:	Po Box 381 Darwin NT, Australia	**REPORT NO:**	ES1911591-007 / PSD
PROJECT:	EZ19041 Santos Soil Sampling - April 2019	**SAMPLE ID:**	ESCP1

Particle Size Distribution



Particle Size (mm)	% Passing
19.0	100%
9.50	98%
4.75	90%
2.36	80%
1.18	73%
0.600	72%
0.425	71%
0.300	70%
0.150	65%
0.075	57%
Particle Size (microns)	
47	47%
34	44%
24	43%
18	40%
13	40%
9	39%
6	38%
5	37%
1	34%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	0.062

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Analysed: 29-Apr-19

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: FINES, SAND, GRAVEL

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.62

NATA Accreditation: 825 Site: Newcastle
This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced, except in full.

NATA
WORLD RECOGNISED ACCREDITATION

Dianne Blane
Laboratory Coordinator
Authorised Signatory

Certificate of Analysis

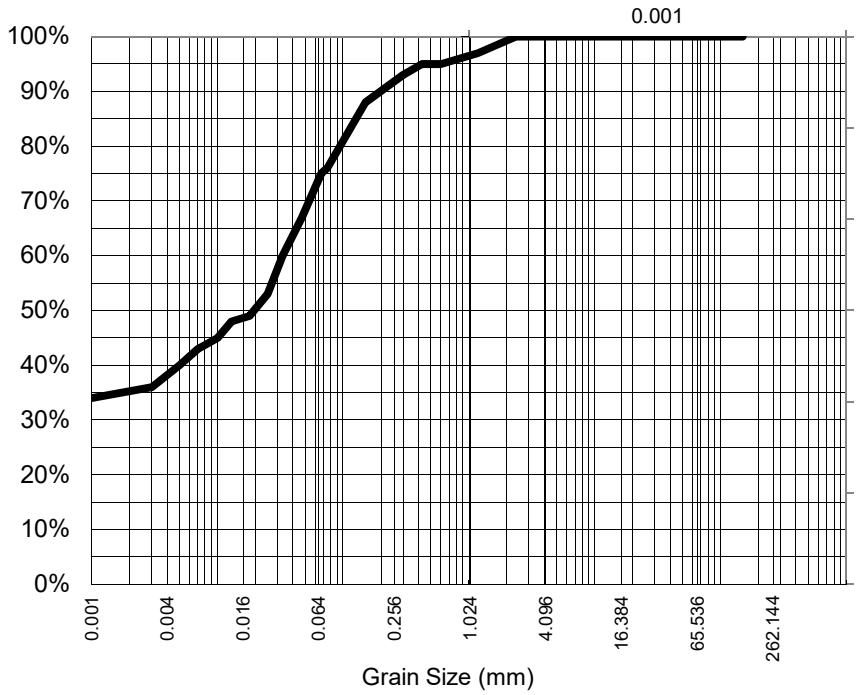
ALS Laboratory Group Pty Ltd
5/585 Maitland Road
Mayfield West, NSW 2304
pH 02 4014 2500
fax 02 4968 0349
samples.newcastle@alsenviro.com

ALS Environmental

Newcastle, NSW

CLIENT:	FELICITY WATT	**DATE REPORTED:**	2-May-2019
COMPANY:	ECOZ ENVIRONMENTAL SERVICES	**DATE RECEIVED:**	16-Apr-2019
ADDRESS:	Po Box 381 Darwin NT, Australia	**REPORT NO:**	ES1911591-008 / PSD
PROJECT:	EZ19041 Santos Soil Sampling - April 2019	**SAMPLE ID:**	ESCP2

Particle Size Distribution



Particle Size (mm)	% Passing
2.36	100%
1.18	97%
0.600	95%
0.425	95%
0.300	93%
0.150	88%
0.075	76%
Particle Size (microns)	
47	67%
33	60%
25	53%
18	49%
13	48%
10	45%
7	43%
5	40%
1	34%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	0.020

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:		**Analysed:**	29-Apr-19
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	FINES, SAND	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3		
Soil Particle Density (<2.36mm)	2.46		

NATA Accreditation: 825 Site: Newcastle
This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced, except in full.

NATA
WORLD RECOGNISED ACCREDITATION

Dianne Blane
Laboratory Coordinator
Authorised Signatory

Certificate of Analysis

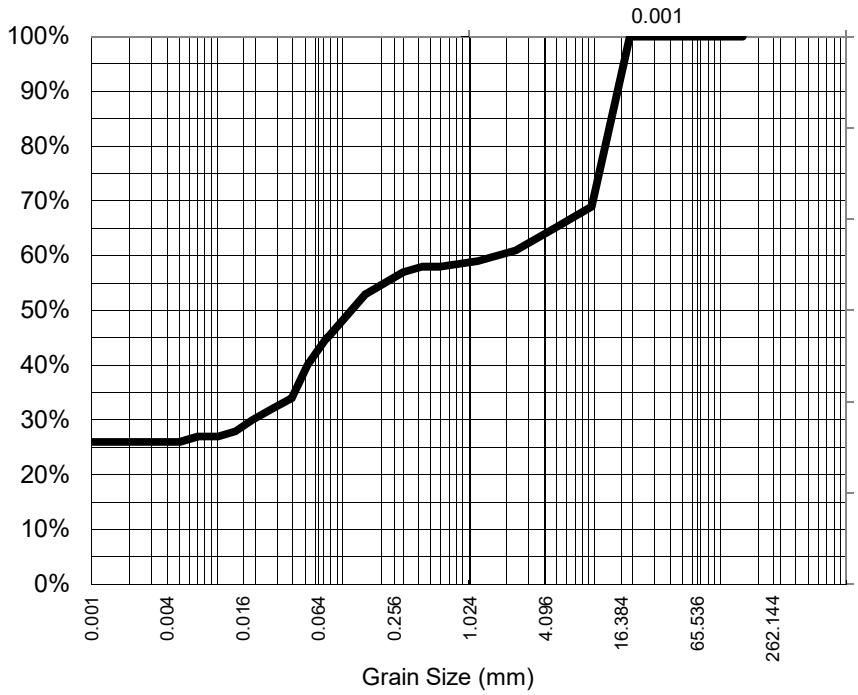
ALS Laboratory Group Pty Ltd
5/585 Maitland Road
Mayfield West, NSW 2304
pH 02 4014 2500
fax 02 4968 0349
samples.newcastle@alsenviro.com

ALS Environmental

Newcastle, NSW

CLIENT:	FELICITY WATT	**DATE REPORTED:**	2-May-2019
COMPANY:	ECOZ ENVIRONMENTAL SERVICES	**DATE RECEIVED:**	16-Apr-2019
ADDRESS:	Po Box 381 Darwin NT, Australia	**REPORT NO:**	ES1911591-009 / PSD
PROJECT:	EZ19041 Santos Soil Sampling - April 2019	**SAMPLE ID:**	ESCP3

Particle Size Distribution



Particle Size (mm)	% Passing
19.0	100%
9.50	69%
4.75	65%
2.36	61%
1.18	59%
0.600	58%
0.425	58%
0.300	57%
0.150	53%
0.075	45%
Particle Size (microns)	
52	40%
39	34%
27	32%
19	30%
14	28%
10	27%
7	27%
5	26%
1	26%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	0.122

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Analysed: 29-Apr-19

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: FINES, GRAVEL, SAND

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.46

NATA Accreditation: 825 Site: Newcastle
This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced, except in full.

NATA
WORLD RECOGNISED ACCREDITATION

Dianne Blane
Laboratory Coordinator
Authorised Signatory

Certificate of Analysis

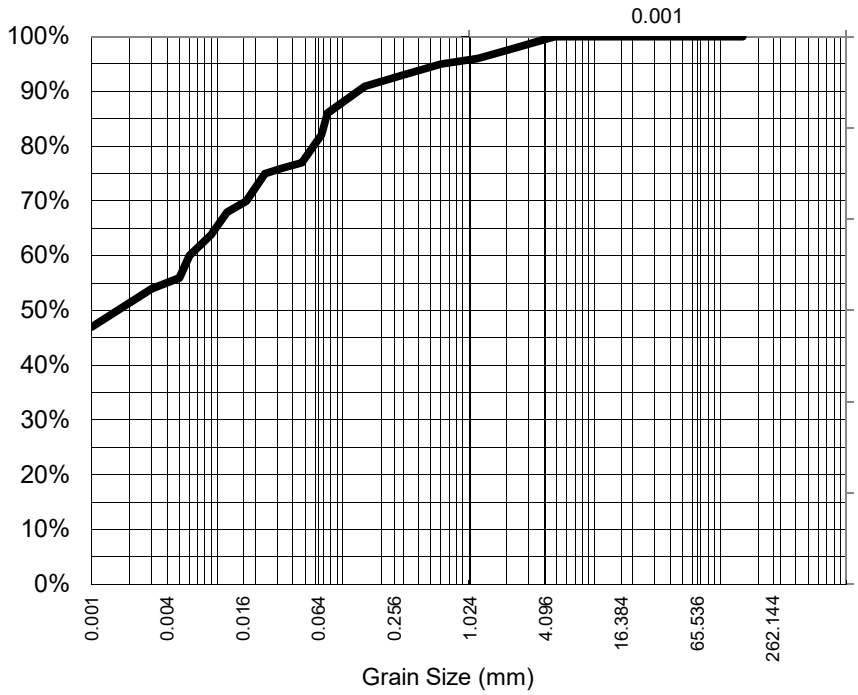
ALS Laboratory Group Pty Ltd
5/585 Maitland Road
Mayfield West, NSW 2304
pH 02 4014 2500
fax 02 4968 0349
samples.newcastle@alsenviro.com

ALS Environmental

Newcastle, NSW

CLIENT:	FELICITY WATT	**DATE REPORTED:**	2-May-2019
COMPANY:	ECOZ ENVIRONMENTAL SERVICES	**DATE RECEIVED:**	16-Apr-2019
ADDRESS:	Po Box 381 Darwin NT, Australia	**REPORT NO:**	ES1911591-010 / PSD
PROJECT:	EZ19041 Santos Soil Sampling - April 2019	**SAMPLE ID:**	ESCP4

Particle Size Distribution



Particle Size (mm)	% Passing
4.75	100%
2.36	98%
1.18	96%
0.600	95%
0.425	94%
0.300	93%
0.150	91%
0.075	86%
Particle Size (microns)	
47	77%
33	76%
24	75%
17	70%
12	68%
9	64%
6	60%
5	56%
1	47%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	<0.006

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:		**Analysed:**	29-Apr-19
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	FINES, SAND	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3		
Soil Particle Density (<2.36mm)	2.48		

NATA Accreditation: 825 Site: Newcastle
This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced, except in full.

NATA
WORLD RECOGNISED ACCREDITATION

Dianne Blane
Laboratory Coordinator
Authorised Signatory

Certificate of Analysis

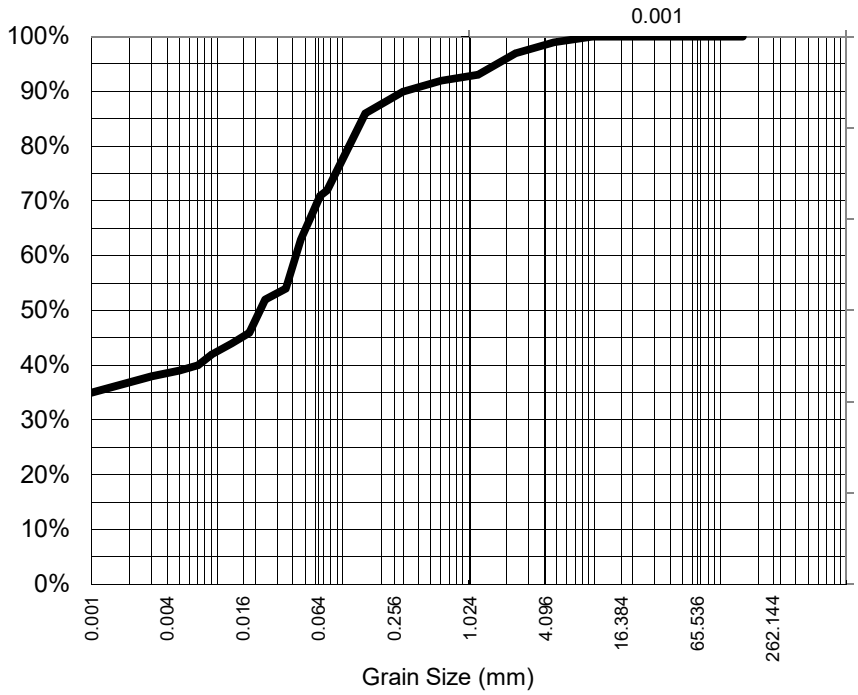
ALS Laboratory Group Pty Ltd
5/585 Maitland Road
Mayfield West, NSW 2304
pH 02 4014 2500
fax 02 4968 0349
samples.newcastle@alsenviro.com

ALS Environmental

Newcastle, NSW

CLIENT:	FELICITY WATT	**DATE REPORTED:**	2-May-2019
COMPANY:	ECOZ ENVIRONMENTAL SERVICES	**DATE RECEIVED:**	16-Apr-2019
ADDRESS:	Po Box 381 Darwin NT, Australia	**REPORT NO:**	ES1911591-011 / PSD
PROJECT:	EZ19041 Santos Soil Sampling - April 2019	**SAMPLE ID:**	ESCP5

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	99%
2.36	97%
1.18	93%
0.600	92%
0.425	91%
0.300	90%
0.150	86%
0.075	72%
Particle Size (microns)	
46	63%
35	54%
24	52%
18	46%
13	44%
9	42%
7	40%
5	39%
1	35%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	0.022

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:		**Analysed:**	29-Apr-19
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	FINES, SAND	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3		
Soil Particle Density (<2.36mm)	2.5		

NATA Accreditation: 825 Site: Newcastle
This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced, except in full.

NATA
WORLD RECOGNISED ACCREDITATION

Dianne Blane
Laboratory Coordinator
Authorised Signatory

Certificate of Analysis

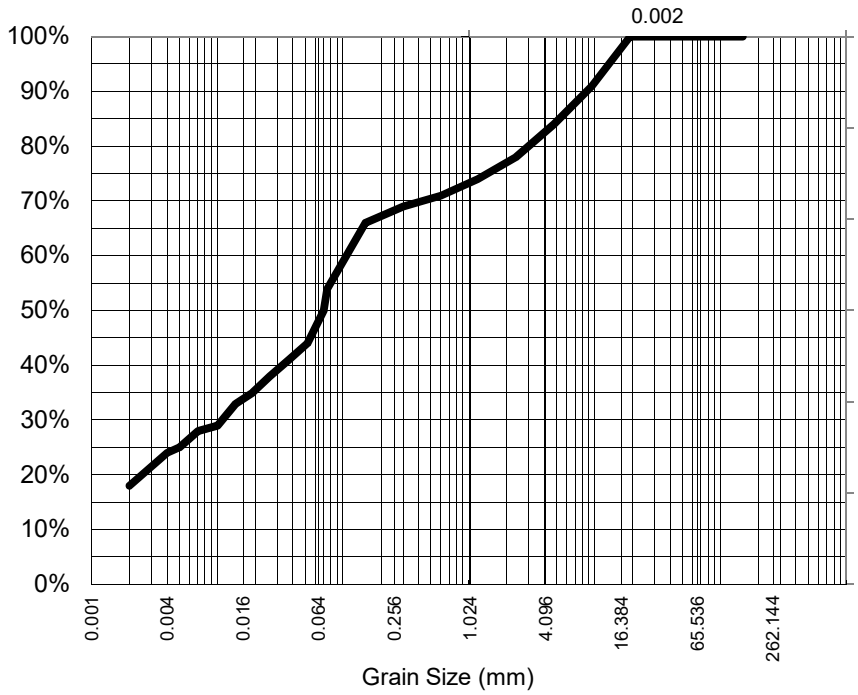
ALS Laboratory Group Pty Ltd
5/585 Maitland Road
Mayfield West, NSW 2304
pH 02 4014 2500
fax 02 4968 0349
samples.newcastle@alsenviro.com

ALS Environmental

Newcastle, NSW

CLIENT:	FELICITY WATT	**DATE REPORTED:**	2-May-2019
COMPANY:	ECOZ ENVIRONMENTAL SERVICES	**DATE RECEIVED:**	16-Apr-2019
ADDRESS:	Po Box 381 Darwin NT, Australia	**REPORT NO:**	ES1911591-012 / PSD
PROJECT:	EZ19041 Santos Soil Sampling - April 2019	**SAMPLE ID:**	ESCP6

Particle Size Distribution



Particle Size (mm)	% Passing
19.0	100%
9.50	91%
4.75	84%
2.36	78%
1.18	74%
0.600	71%
0.425	70%
0.300	69%
0.150	66%
0.075	54%
Particle Size (microns)	
52	44%
37	41%
26	38%
19	35%
14	33%
10	29%
7	28%
5	25%
2	18%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	0.070

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Analysed: 29-Apr-19

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: FINES, SAND, GRAVEL

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.46

NATA Accreditation: 825 Site: Newcastle
This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced, except in full.

NATA
WORLD RECOGNISED ACCREDITATION

Dianne Blane
Laboratory Coordinator
Authorised Signatory

Certificate of Analysis

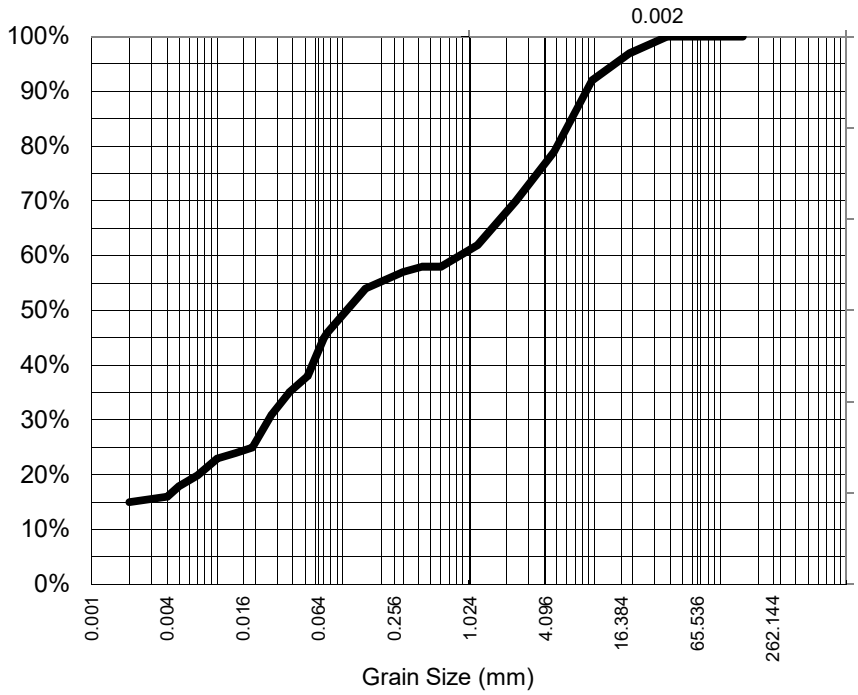
ALS Laboratory Group Pty Ltd
5/585 Maitland Road
Mayfield West, NSW 2304
pH 02 4014 2500
fax 02 4968 0349
samples.newcastle@alsenviro.com

ALS Environmental

Newcastle, NSW

CLIENT:	FELICITY WATT	**DATE REPORTED:**	2-May-2019
COMPANY:	ECOZ ENVIRONMENTAL SERVICES	**DATE RECEIVED:**	16-Apr-2019
ADDRESS:	Po Box 381 Darwin NT, Australia	**REPORT NO:**	ES1911591-013 / PSD
PROJECT:	EZ19041 Santos Soil Sampling - April 2019	**SAMPLE ID:**	INA1 CP 0

Particle Size Distribution



Particle Size (mm)	% Passing
37.5	100%
19.0	97%
9.50	92%
4.75	79%
2.36	70%
1.18	62%
0.600	58%
0.425	58%
0.300	57%
0.150	54%
0.075	46%
Particle Size (microns)	
52	38%
37	35%
27	31%
19	25%
14	24%
10	23%
7	20%
5	18%
2	15%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	0.113

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Analysed: 29-Apr-19

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: FINES, SAND, GRAVEL

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.49

NATA Accreditation: 825 Site: Newcastle
This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced, except in full.

NATA
WORLD RECOGNISED ACCREDITATION

Dianne Blane
Laboratory Coordinator
Authorised Signatory

Certificate of Analysis

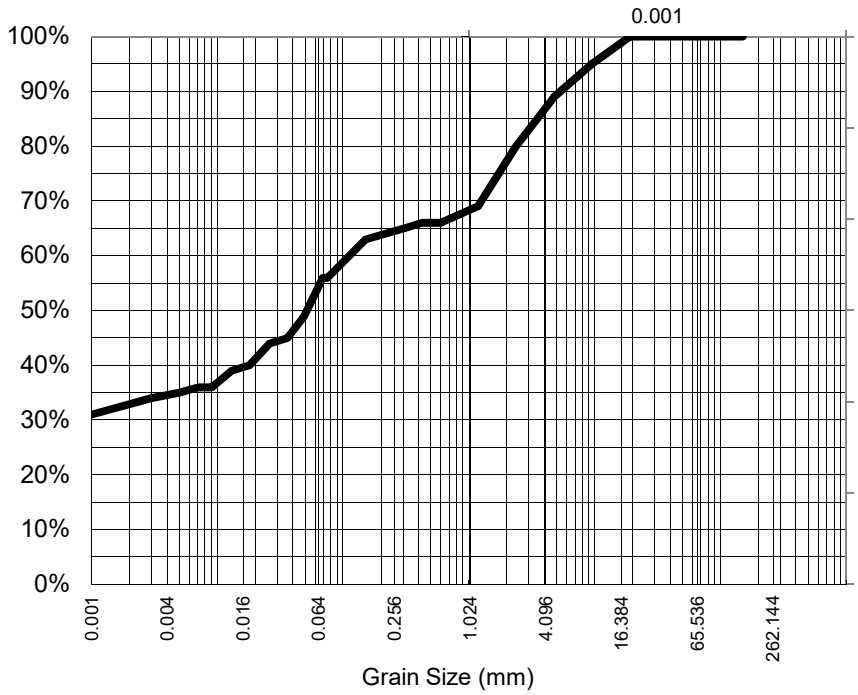
ALS Laboratory Group Pty Ltd
5/585 Maitland Road
Mayfield West, NSW 2304
pH 02 4014 2500
fax 02 4968 0349
samples.newcastle@alsenviro.com

ALS Environmental

Newcastle, NSW

CLIENT:	FELICITY WATT	**DATE REPORTED:**	2-May-2019
COMPANY:	ECOZ ENVIRONMENTAL SERVICES	**DATE RECEIVED:**	16-Apr-2019
ADDRESS:	Po Box 381 Darwin NT, Australia	**REPORT NO:**	ES1911591-014 / PSD
PROJECT:	EZ19041 Santos Soil Sampling - April 2019	**SAMPLE ID:**	INA1 CP 30

Particle Size Distribution



Particle Size (mm)	% Passing
19.0	100%
9.50	95%
4.75	89%
2.36	80%
1.18	69%
0.600	66%
0.425	66%
0.300	65%
0.150	63%
0.075	56%
Particle Size (microns)	
49	49%
36	45%
26	44%
18	40%
13	39%
9	36%
7	36%
5	35%
1	31%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	0.052

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:		**Analysed:**	29-Apr-19
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	FINES, SAND, GRAVEL	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3		
Soil Particle Density (<2.36mm)	2.54		

NATA Accreditation: 825 Site: Newcastle
This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced, except in full.

NATA
WORLD RECOGNISED ACCREDITATION

Dianne Blane
Laboratory Coordinator
Authorised Signatory

Certificate of Analysis

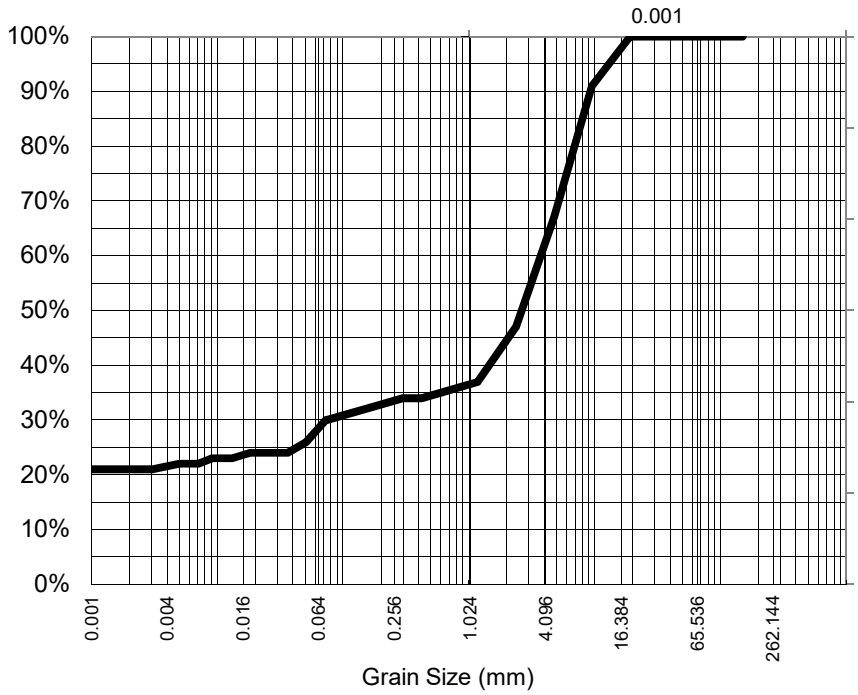
ALS Laboratory Group Pty Ltd
5/585 Maitland Road
Mayfield West, NSW 2304
pH 02 4014 2500
fax 02 4968 0349
samples.newcastle@alsenviro.com

ALS Environmental

Newcastle, NSW

CLIENT:	FELICITY WATT	**DATE REPORTED:**	2-May-2019
COMPANY:	ECOZ ENVIRONMENTAL SERVICES	**DATE RECEIVED:**	16-Apr-2019
ADDRESS:	Po Box 381 Darwin NT, Australia	**REPORT NO:**	ES1911591-015 / PSD
PROJECT:	EZ19041 Santos Soil Sampling - April 2019	**SAMPLE ID:**	INA1 CP 60

Particle Size Distribution



Particle Size (mm)	% Passing
19.0	100%
9.50	91%
4.75	67%
2.36	47%
1.18	37%
0.600	35%
0.425	34%
0.300	34%
0.150	32%
0.075	30%
Particle Size (microns)	
51	26%
36	24%
26	24%
18	24%
13	23%
9	23%
7	22%
5	22%
1	21%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	2.719

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:		**Analysed:**	29-Apr-19
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	GRAVEL,FINES, SAND	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3		
Soil Particle Density (<2.36mm)	2.67		

NATA Accreditation: 825 Site: Newcastle
This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced, except in full.

Dianne Blane
Laboratory Coordinator
Authorised Signatory

Certificate of Analysis

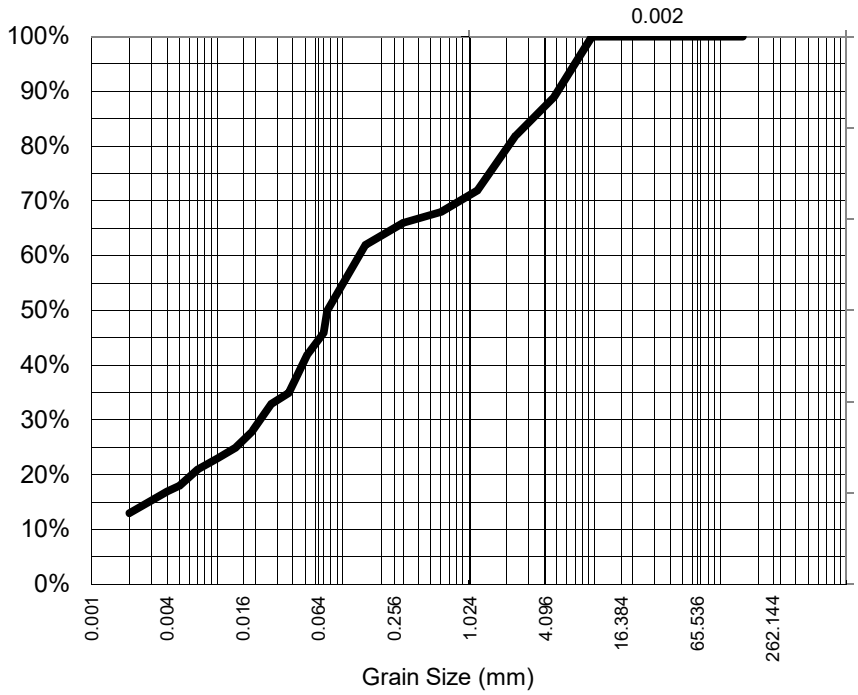
ALS Laboratory Group Pty Ltd
5/585 Maitland Road
Mayfield West, NSW 2304
pH 02 4014 2500
fax 02 4968 0349
samples.newcastle@alsenviro.com

ALS Environmental

Newcastle, NSW

CLIENT:	FELICITY WATT	**DATE REPORTED:**	2-May-2019
COMPANY:	ECOZ ENVIRONMENTAL SERVICES	**DATE RECEIVED:**	16-Apr-2019
ADDRESS:	Po Box 381 Darwin NT, Australia	**REPORT NO:**	ES1911591-016 / PSD
PROJECT:	EZ19041 Santos Soil Sampling - April 2019	**SAMPLE ID:**	INA1 DP 0

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	89%
2.36	82%
1.18	72%
0.600	68%
0.425	67%
0.300	66%
0.150	62%
0.075	50%
Particle Size (microns)	
52	42%
37	35%
27	33%
19	28%
14	25%
10	23%
7	21%
5	18%
2	13%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	0.075

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:		**Analysed:**	29-Apr-19
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	FINES, SAND, GRAVEL	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3		
Soil Particle Density (<2.36mm)	2.48		

NATA Accreditation: 825 Site: Newcastle
This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced, except in full.

NATA
WORLD RECOGNISED ACCREDITATION

Dianne Blane
Laboratory Coordinator
Authorised Signatory

Certificate of Analysis

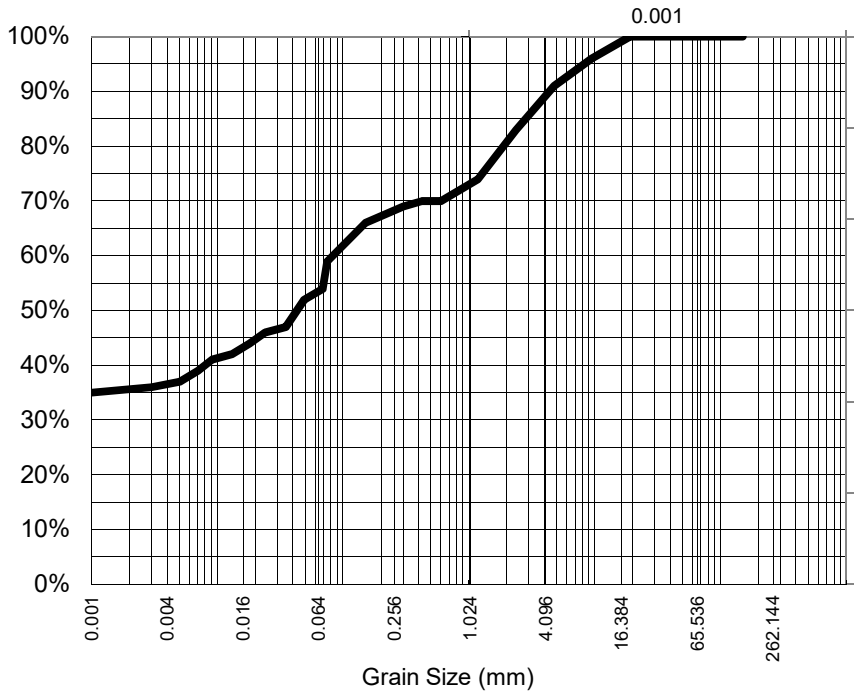
ALS Laboratory Group Pty Ltd
5/585 Maitland Road
Mayfield West, NSW 2304
pH 02 4014 2500
fax 02 4968 0349
samples.newcastle@alsenviro.com

ALS Environmental

Newcastle, NSW

CLIENT:	FELICITY WATT	**DATE REPORTED:**	2-May-2019
COMPANY:	ECOZ ENVIRONMENTAL SERVICES	**DATE RECEIVED:**	16-Apr-2019
ADDRESS:	Po Box 381 Darwin NT, Australia	**REPORT NO:**	ES1911591-017 / PSD
PROJECT:	EZ19041 Santos Soil Sampling - April 2019	**SAMPLE ID:**	INA1 DP 30

Particle Size Distribution



Particle Size (mm)	% Passing
19.0	100%
9.50	96%
4.75	91%
2.36	83%
1.18	74%
0.600	70%
0.425	70%
0.300	69%
0.150	66%
0.075	59%
Particle Size (microns)	
49	52%
35	47%
24	46%
18	44%
13	42%
9	41%
7	39%
5	37%
1	35%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	0.043

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:		**Analysed:**	29-Apr-19
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	FINES, SAND, GRAVEL	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3		
Soil Particle Density (<2.36mm)	2.51		

NATA Accreditation: 825 Site: Newcastle
This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced, except in full.

NATA
WORLD RECOGNISED ACCREDITATION

Dianne Blane
Laboratory Coordinator
Authorised Signatory

Certificate of Analysis

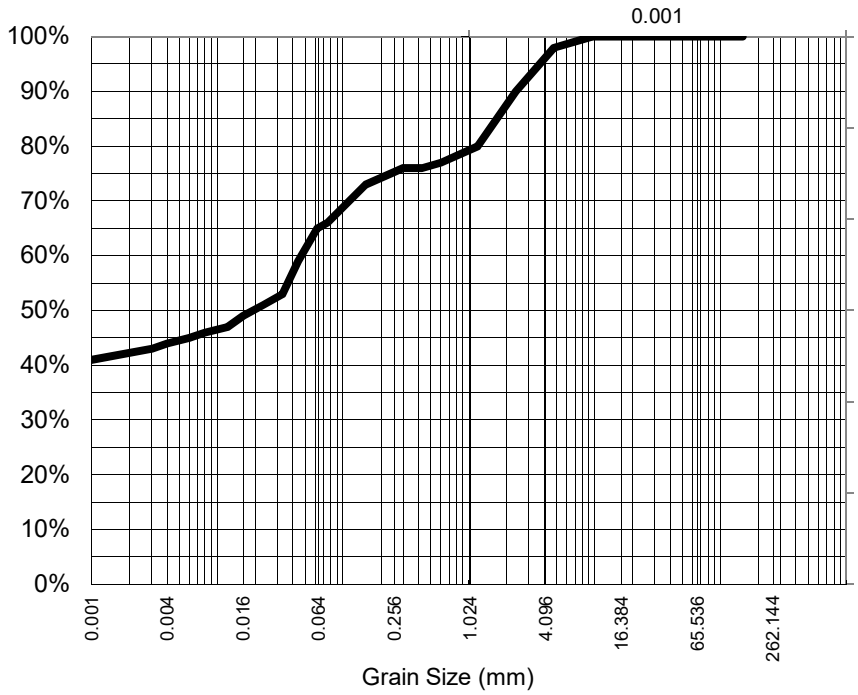
ALS Laboratory Group Pty Ltd
5/585 Maitland Road
Mayfield West, NSW 2304
pH 02 4014 2500
fax 02 4968 0349
samples.newcastle@alsenviro.com

ALS Environmental

Newcastle, NSW

CLIENT:	FELICITY WATT	**DATE REPORTED:**	2-May-2019
COMPANY:	ECOZ ENVIRONMENTAL SERVICES	**DATE RECEIVED:**	16-Apr-2019
ADDRESS:	Po Box 381 Darwin NT, Australia	**REPORT NO:**	ES1911591-018 / PSD
PROJECT:	EZ19041 Santos Soil Sampling - April 2019	**SAMPLE ID:**	INA1 DP 60

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	98%
2.36	90%
1.18	80%
0.600	77%
0.425	76%
0.300	76%
0.150	73%
0.075	66%
Particle Size (microns)	
44	59%
33	53%
23	51%
16	49%
12	47%
8	46%
6	45%
4	44%
1	41%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	0.020

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:		**Analysed:**	29-Apr-19
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	FINES, SAND, GRAVEL	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3		
Soil Particle Density (<2.36mm)	2.72		

NATA Accreditation: 825 Site: Newcastle
This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced, except in full.

NATA
WORLD RECOGNISED ACCREDITATION

Dianne Blane
Laboratory Coordinator
Authorised Signatory

Certificate of Analysis

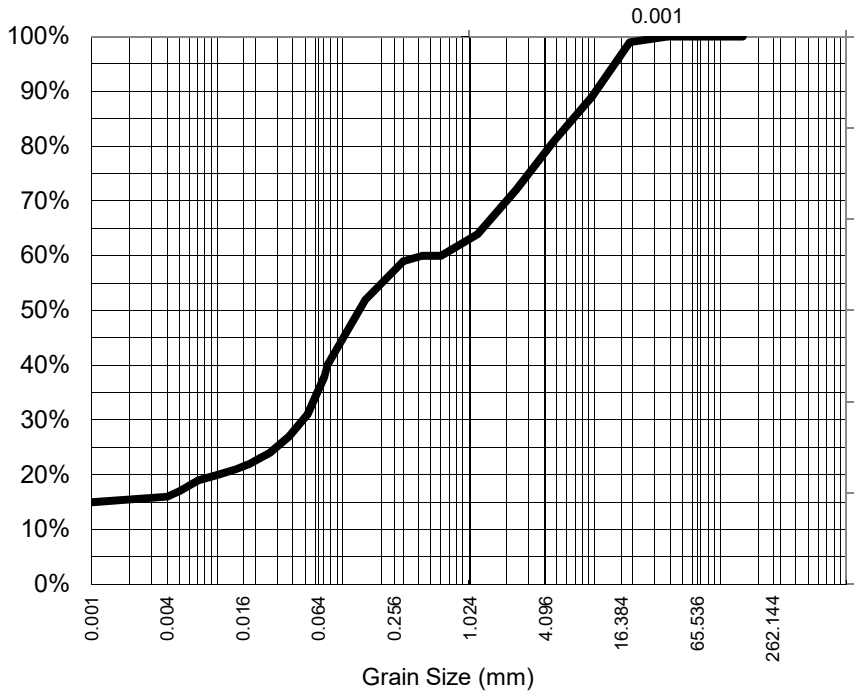
ALS Laboratory Group Pty Ltd
5/585 Maitland Road
Mayfield West, NSW 2304
pH 02 4014 2500
fax 02 4968 0349
samples.newcastle@alsenviro.com

ALS Environmental

Newcastle, NSW

CLIENT:	FELICITY WATT	**DATE REPORTED:**	2-May-2019
COMPANY:	ECOZ ENVIRONMENTAL SERVICES	**DATE RECEIVED:**	16-Apr-2019
ADDRESS:	Po Box 381 Darwin NT, Australia	**REPORT NO:**	ES1911591-019 / PSD
PROJECT:	EZ19041 Santos Soil Sampling - April 2019	**SAMPLE ID:**	INA1 WT 0

Particle Size Distribution



Particle Size (mm)	% Passing
37.5	100%
19.0	99%
9.50	89%
4.75	81%
2.36	72%
1.18	64%
0.600	60%
0.425	60%
0.300	59%
0.150	52%
0.075	40%
Particle Size (microns)	
52	31%
37	27%
26	24%
18	22%
14	21%
10	20%
7	19%
5	17%
1	15%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	0.138

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Analysed: 29-Apr-19

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: FINES, SAND, GRAVEL

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.64

NATA Accreditation: 825 Site: Newcastle
This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced, except in full.

NATA
WORLD RECOGNISED ACCREDITATION

Dianne Blane
Laboratory Coordinator
Authorised Signatory

Certificate of Analysis

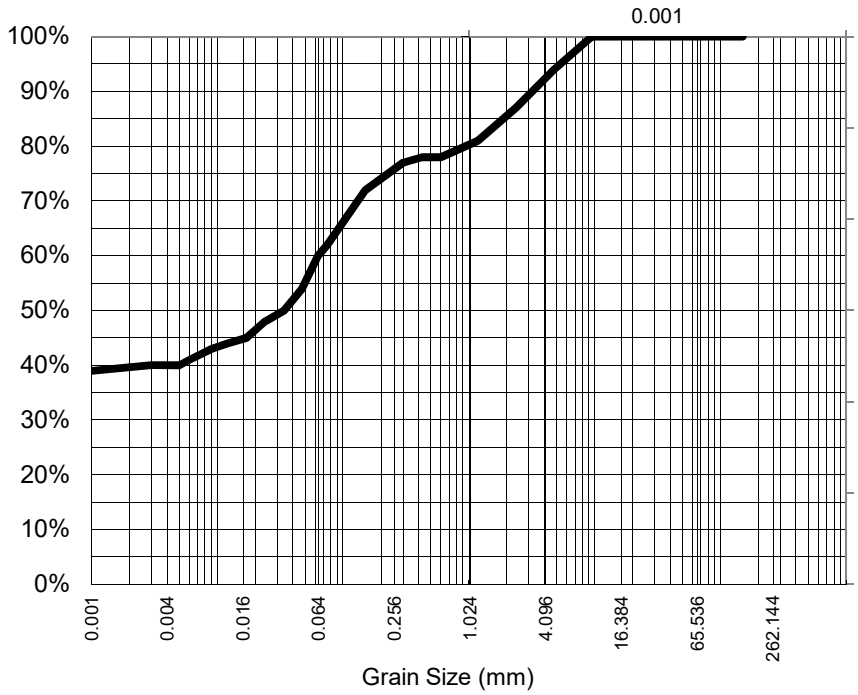
ALS Laboratory Group Pty Ltd
5/585 Maitland Road
Mayfield West, NSW 2304
pH 02 4014 2500
fax 02 4968 0349
samples.newcastle@alsenviro.com

ALS Environmental

Newcastle, NSW

CLIENT:	FELICITY WATT	**DATE REPORTED:**	2-May-2019
COMPANY:	ECOZ ENVIRONMENTAL SERVICES	**DATE RECEIVED:**	16-Apr-2019
ADDRESS:	Po Box 381 Darwin NT, Australia	**REPORT NO:**	ES1911591-020 / PSD
PROJECT:	EZ19041 Santos Soil Sampling - April 2019	**SAMPLE ID:**	INA1 WT 30

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	94%
2.36	87%
1.18	81%
0.600	78%
0.425	78%
0.300	77%
0.150	72%
0.075	62%
Particle Size (microns)	
47	54%
34	50%
24	48%
17	45%
12	44%
9	43%
6	41%
5	40%
1	39%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	0.034

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:		**Analysed:**	29-Apr-19
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	FINES, SAND, GRAVEL	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3		
Soil Particle Density (<2.36mm)	2.6		

NATA Accreditation: 825 Site: Newcastle
This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced, except in full.

NATA
WORLD RECOGNISED ACCREDITATION

Dianne Blane
Laboratory Coordinator
Authorised Signatory

Certificate of Analysis

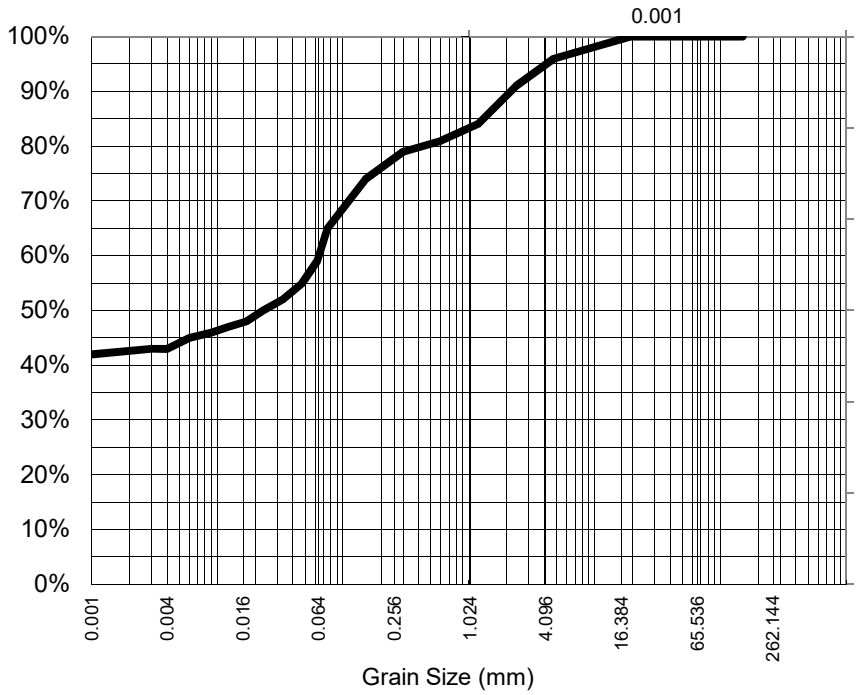
ALS Laboratory Group Pty Ltd
5/585 Maitland Road
Mayfield West, NSW 2304
pH 02 4014 2500
fax 02 4968 0349
samples.newcastle@alsenviro.com

ALS Environmental

Newcastle, NSW

CLIENT:	FELICITY WATT	**DATE REPORTED:**	2-May-2019
COMPANY:	ECOZ ENVIRONMENTAL SERVICES	**DATE RECEIVED:**	16-Apr-2019
ADDRESS:	Po Box 381 Darwin NT, Australia	**REPORT NO:**	ES1911591-021 / PSD
PROJECT:	EZ19041 Santos Soil Sampling - April 2019	**SAMPLE ID:**	INA1 WT 60

Particle Size Distribution



Particle Size (mm)	% Passing
19.0	100%
9.50	98%
4.75	96%
2.36	91%
1.18	84%
0.600	81%
0.425	80%
0.300	79%
0.150	74%
0.075	65%
Particle Size (microns)	
47	55%
33	52%
23	50%
17	48%
12	47%
9	46%
6	45%
4	43%
1	42%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	0.023

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:		**Analysed:**	29-Apr-19
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	FINES, SAND, GRAVEL	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3		
Soil Particle Density (<2.36mm)	2.67		

NATA Accreditation: 825 Site: Newcastle
This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced, except in full.

NATA
WORLD RECOGNISED ACCREDITATION

Dianne Blane
Laboratory Coordinator
Authorised Signatory

Certificate of Analysis

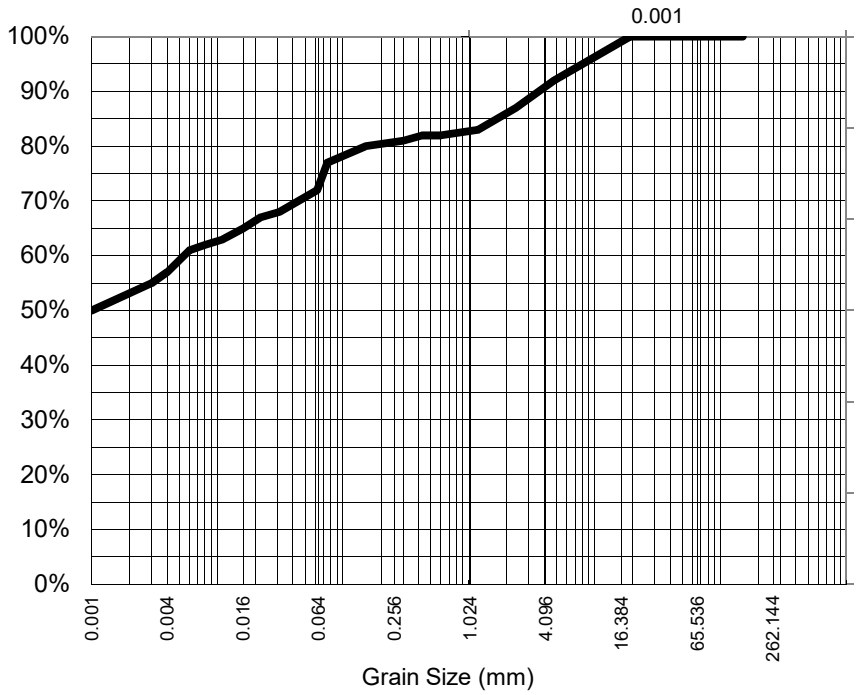
ALS Laboratory Group Pty Ltd
5/585 Maitland Road
Mayfield West, NSW 2304
pH 02 4014 2500
fax 02 4968 0349
samples.newcastle@alsenviro.com

ALS Environmental

Newcastle, NSW

CLIENT:	FELICITY WATT	**DATE REPORTED:**	2-May-2019
COMPANY:	ECOZ ENVIRONMENTAL SERVICES	**DATE RECEIVED:**	16-Apr-2019
ADDRESS:	Po Box 381 Darwin NT, Australia	**REPORT NO:**	ES1911591-022 / PSD
PROJECT:	EZ19041 Santos Soil Sampling - April 2019	**SAMPLE ID:**	TAN2 DP 0

Particle Size Distribution



Particle Size (mm)	% Passing
19.0	100%
9.50	96%
4.75	92%
2.36	87%
1.18	83%
0.600	82%
0.425	82%
0.300	81%
0.150	80%
0.075	77%
Particle Size (microns)	
44	70%
31	68%
22	67%
16	65%
11	63%
8	62%
6	61%
4	57%
1	50%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	<0.006

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Analysed: 29-Apr-19

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: FINES, SAND, GRAVEL

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.65

NATA Accreditation: 825 Site: Newcastle
This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced, except in full.

NATA
WORLD RECOGNISED ACCREDITATION

Dianne Blane
Laboratory Coordinator
Authorised Signatory

Certificate of Analysis

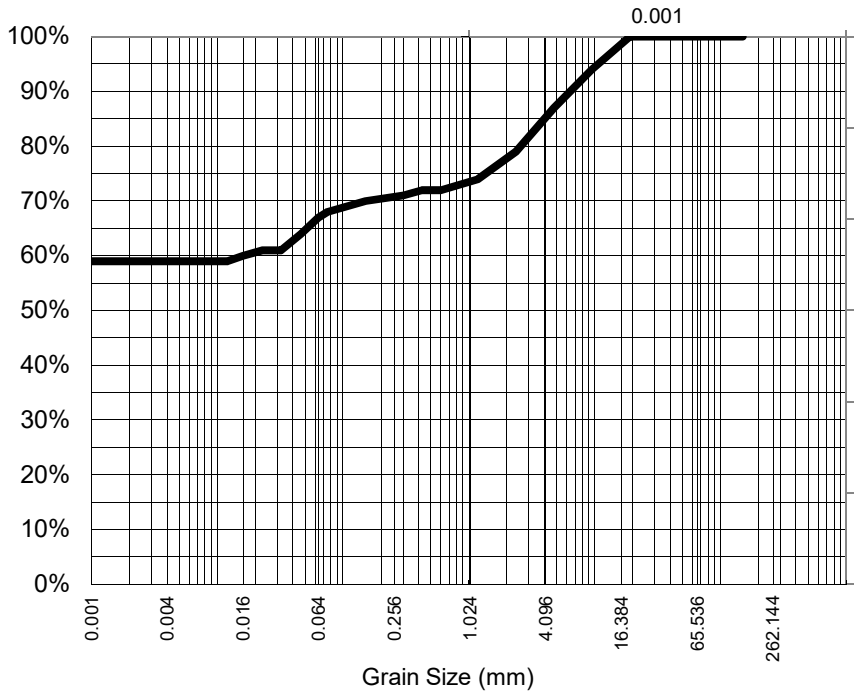
ALS Laboratory Group Pty Ltd
5/585 Maitland Road
Mayfield West, NSW 2304
pH 02 4014 2500
fax 02 4968 0349
samples.newcastle@alsenviro.com

ALS Environmental

Newcastle, NSW

CLIENT:	FELICITY WATT	**DATE REPORTED:**	2-May-2019
COMPANY:	ECOZ ENVIRONMENTAL SERVICES	**DATE RECEIVED:**	16-Apr-2019
ADDRESS:	Po Box 381 Darwin NT, Australia	**REPORT NO:**	ES1911591-023 / PSD
PROJECT:	EZ19041 Santos Soil Sampling - April 2019	**SAMPLE ID:**	TAN2 DP 30

Particle Size Distribution



Particle Size (mm)	% Passing
19.0	100%
9.50	94%
4.75	87%
2.36	79%
1.18	74%
0.600	72%
0.425	72%
0.300	71%
0.150	70%
0.075	68%
Particle Size (microns)	
46	64%
32	61%
23	61%
16	60%
12	59%
8	59%
6	59%
4	59%
1	59%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	<0.006

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Analysed: 29-Apr-19

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: FINES, SAND, GRAVEL

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.59

NATA Accreditation: 825 Site: Newcastle
This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced, except in full.

NATA
WORLD RECOGNISED ACCREDITATION

Dianne Blane
Laboratory Coordinator
Authorised Signatory

Certificate of Analysis

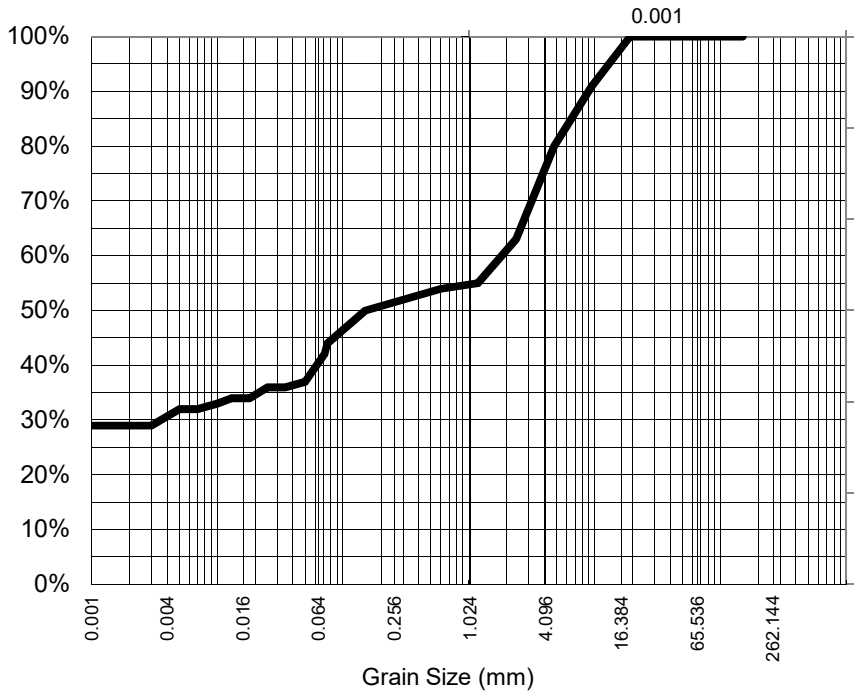
ALS Laboratory Group Pty Ltd
5/585 Maitland Road
Mayfield West, NSW 2304
pH 02 4014 2500
fax 02 4968 0349
samples.newcastle@alsenviro.com

ALS Environmental

Newcastle, NSW

CLIENT:	FELICITY WATT	**DATE REPORTED:**	2-May-2019
COMPANY:	ECOZ ENVIRONMENTAL SERVICES	**DATE RECEIVED:**	16-Apr-2019
ADDRESS:	Po Box 381 Darwin NT, Australia	**REPORT NO:**	ES1911591-024 / PSD
PROJECT:	EZ19041 Santos Soil Sampling - April 2019	**SAMPLE ID:**	TAN2 DP 60

Particle Size Distribution



Particle Size (mm)	% Passing
19.0	100%
9.50	91%
4.75	80%
2.36	63%
1.18	55%
0.600	54%
0.425	53%
0.300	52%
0.150	50%
0.075	44%
Particle Size (microns)	
50	37%
35	36%
25	36%
18	34%
13	34%
10	33%
7	32%
5	32%
1	29%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	0.150

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Analysed: 29-Apr-19

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: GRAVEL,FINES, SAND

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.62

NATA Accreditation: 825 Site: Newcastle
This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced, except in full.

NATA
WORLD RECOGNISED ACCREDITATION

Dianne Blane
Laboratory Coordinator
Authorised Signatory

EcOz Pty Ltd.
ABN 81 143 989 039

Winlow House, 3rd Floor
75 Woods Street
Darwin NT 0800

GPO Box 381,
Darwin NT 0800

T: +61 8 8981 1100
F: +61 8 8981 1102
E: ecoz@ecoz.com.au

www.ecoz.com.au

Appendix F: Weed Management Plan

Weed Management Plan

2019 exploration program - EP 161

Santos

www.ecoz.com.au

DOCUMENT CONTROL RECORD

Job	EZ19041
Document ID	176876-11
Author(s)	Felicity Watt,

DOCUMENT HISTORY

Rev	Reviewed by	Approved by	Issued to	Date
1	A. Campbell	R. Hall	Client	04/04/19

Recipients are responsible for eliminating all superseded documents in their possession.

EcOz Pty Ltd.
ABN: 81 143 989 039
Winlow House, 3rd Floor
75 Woods Street
DARWIN NT 0800
GPO Box 381, Darwin NT 0800

Telephone: +61 8 8981 1100
Facsimile: +61 8 8981 1102
Email: ecoz@ecoz.com.au
Internet: www.ecoz.com.au

TABLE OF CONTENTS

Appendices

Tables

Figures

1 INTRODUCTION

Santos plan to undertake exploration works within their onshore shale gas exploration permit (EP) on Tanumbirini Station (EP 161). This work includes the installation of two exploration wells, associated civil works and infrastructure development, to be undertaken in 2019. The exploration works will be regulated through an Environmental Management Plan (EMP) approved by the Department of Environment and Natural Resources (DENR). EcOz were engaged to prepare an associated weed management plan – this document – required as a component of the EMP under the *Petroleum (Environment) Regulations* (the Regulations).

1.1 Scope & objectives

The scope of this weed management plan is to outline the weed management measures that will be implemented to prevent the introduction and spread of weeds during the works associated with the exploration program.

The objectives of this weed management plan are to:

- Comply with all applicable legislation, regulations, conditions and regional weed management plans.
- Address the specific weed management requirements of station owners.
- Provide controls for construction activities to avoid introducing new weed species into the 2019 exploration program project area.
- Avoid or control the spread of existing weed species into new areas within the exploration program project area.
- Detail the monitoring, reporting and incident response procedures appropriate for the management measures.

The weed management plan is applicable to all activities associated with the exploration program, and will be used by all personnel (including contractors) involved in program activities.

1.2 Dedicated weed officer

The *Scientific Inquiry into Hydraulic Fracturing* recommended a dedicated weed officer for each gas field. Contact details for Santos' weed officer for EP 161 are:

Mitch Bird, Senior Environmental Advisor, Tel: 07 3838 3799, Email: mitch.bird@santos.com

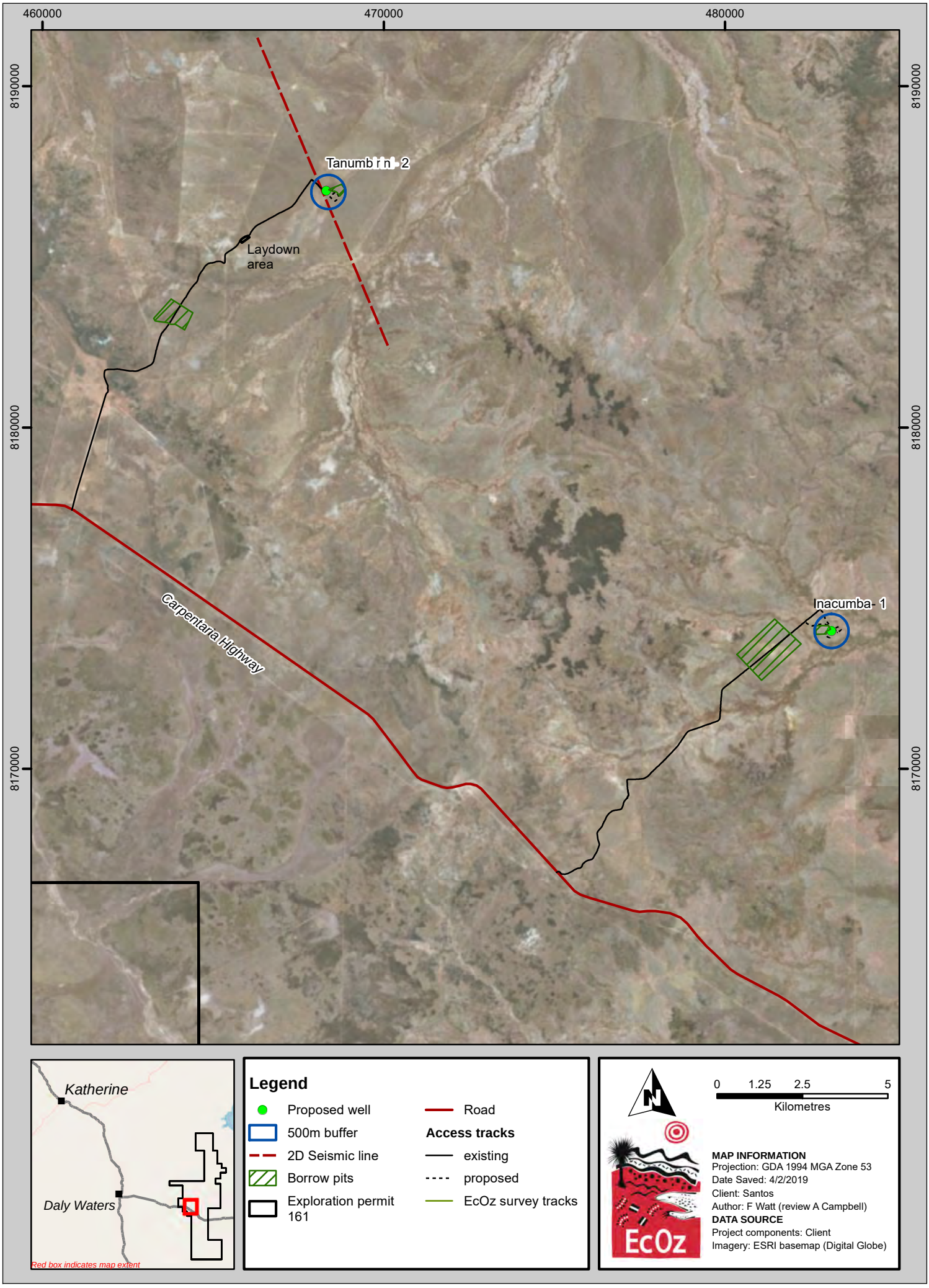
1.3 Project area

EP 161 is located on Tanumbirini Station on the Carpentaria Highway south east of Katherine. Activities involved with the 2019 exploration program project area are mapped in

Figure 1-1 and include:

- Drilling of two new exploration wells – Tanumbirini-2 and Inacumba-1. All disturbance for the wells (well drill pad, camps, dams etc) will be located within a 500 m buffer of the proposed well locations.
- A single 2D seismic profiling line crossing the proposed Tanumbirini-2 well site
- Construction of two short access tracks ~900 m each, from existing station tracks to the proposed well sites

- Clearing for a laydown area along the access track to Tanumbirini-2, and for borrow material. Two borrow pit locations have been identified; borrow material will come from only a portion of the identified area, with pits located within one or both identified locations.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19041 - Santos EP161 EMP aspects\01 Project Files\WMP Figure 1-1. Map showing 2019 project area.mxd

Figure 1-1. Map showing 2019 project area

2 LEGAL REQUIREMENTS

This following legislation, statutory obligations and guidelines were considered during the preparation of this weed management plan.

2.1.1 Petroleum (Environment) Regulations

The Petroleum (Environment) Regulations, (the Regulations), require submission of an EMP prior to any petroleum exploration or production activity. This weed management plan represents of component of the 2019 exploration program EMP, as required under the regulations.

2.1.2 Weeds Management Act

This Act aims to:

> *Protect the Territory's economy, community, industry and environment from the adverse impact of weeds*

It declares undesirable species of plants as weeds, and requires these species to be controlled, eradicated or prevented from entering the Northern Territory (NT) depending on their classification. Under the Act, weeds are classified into one of three classes:

- Class A declared plant – to be eradicated
- Class B declared plant – growth and spread to be controlled
- Class C declared plant – not to be introduced into the NT (all Class A and B weeds are also Class C)

The Act specifies how weeds in each of the classes must be treated. Weed management plans for specific weeds are endorsed under this Act.

2.1.3 Management plans and guidelines

Statutory Weed Management Plans

These plans are legal documents containing specific information about management requirements for certain high priority weeds. Section 4 lists weeds that are present or have the potential for introduction onto EP 161, and notes those with an associated statutory weed management plan.

Guidelines and standards

The following guidelines associated with the management of weeds in the NT have also been considered during the preparation of this WMP:

- *Northern Territory Weed Management Handbook* (Weed Management Branch, 2015a)
- *Northern Territory Weed Data Collection Manual* (Weed Management Branch, 2015b)

2.1.4 Santos environmental policy

Santos' Corporate Environmental Policy is a public declaration of its understanding of the environmental impacts and risks associated with its operations, as well as a demonstration of its compliance with all relevant environmental, health and safety regulations, legislation and guidelines. A copy is provided as Appendix A.

3 WEED RISK MITIGATION MEASURES

The EMP risk assessment process identified a number of weed introduction and/or spread risks associated with the scope of this plan. Table 3-1 documents these risks as well as the mitigation measures that will be implemented to reduce this risk.

Table 3-1 Weed risk and mitigation measures

Weed risk	Mitigation measures	Measurement criteria	Responsible
Introduction of new weed species to EP 161 from machinery and equipment.	All vehicles / machinery /equipment entering the EP to be cleaned and free of soil and vegetative matter, and have a valid weed hygiene declaration	A register of vehicle / equipment / machinery cleaning is kept.[1] Spot checks on vehicle / equipment / machinery to ensure inspections are completed correctly	Santos Dedicated Weed Officer
	Site environmental inductions for all personnel and contractors to include vehicle weed hygiene requirements	All project staff undertake an environmental induction, to be recorded in the Santos Training Register	Santos Dedicated Weed Officer
Weed spread resulting from vehicles/machinery traversing existing weed infestations	All infestations of declared weeds mapped; all personnel and contractors made aware of existing infestation locations and trained in the identification of existing weeds	All project staff undertake an environmental induction, to be recorded in the Santos Training Register Weed maps and factsheets included as part of environmental induction All operational staff to attend weed identification training delivered by the NT Weed Management Branch	Santos Dedicated Weed Officer
	All vehicles, machinery and equipment to stay on formed access tracks, except for those involved in clearing	All project staff undertake an environmental induction, as recorded in the Santos Training Register	Santos Dedicated Weed Officer
	If infestations are identified during the 2019 program they will be demarcated and avoided, where possible, via a detour around the infestation	Maintain demarcation during operations and inspect (and rectify if needed) daily	Santos Field Representative
	If infestations cannot be avoided, treat prior to traversing using methods set out in Table 5-1. Vehicles/plant to be cleaned and free of soil and vegetative matter prior to moving beyond infestation	Work plan to reflect additional tasks required Spot checks on vehicle / equipment / machinery to ensure inspections are completed correctly	Santos Field Representative / Santos Dedicated Weed Officer

[1] Weed hygiene declaration included as Appendix B.

Weed risk	Mitigation measures	Measurement criteria	Responsible
Existing weed distribution not fully known due to survey conducted outside of prime growth period	Further monitoring to be undertaken, as set out in Section 6 of this document	Annual reporting against this WMP, as per Section 6.3	Santos Dedicated Weed Officer

4 WEED SPECIES

Baseline surveys for weeds were undertaken in August and November 2018 and focused along access tracks, within a 500 m buffer around the proposed exploration wells, and 40 km of linear transects radiating from Tanumbirini-2. The exact location of the 2D seismic line identified in the 2019 exploration program is slightly different to the linear transects surveyed; however, there is one survey transect in close proximity to the proposed 2D seismic line, as seen in Figure 4-1 . The landforms and vegetation through which the updated 2D seismic line passes are consistent with those of this survey transect. The proposed locations of the borrow pits have not been surveyed.

Declared weed species observed are listed in Table 4-1, with locations mapped in

Figure 4-2

Table 4-1. Declared weed species recorded within the EP

Common name	Scientific name	NT Class
Hyptis	*Hyptis suaveolens*	B/C
Rubber Bush[2]	*Calotropis procera*	B/C
Spinyhead sida	*Sida acuta*	B/C
Sicklepod	*Senna obtusifolia*	B/C

Other weed species with the potential to occur in the region more broadly, and considered as part of this plan are shown below in Table 4-2.

Table 4-2. Potential weeds within the exploration permit

	Common name	Scientific name	NT Class	WoNS
Katherine region priority weeds	Mesquite*	*Prosopis spp.*	A/C	Y
	Prickly acacia*	*Vachellia nilotica*	A/C	Y
	Parkinsonia	*Parkinsonia aculeata*	B/C	Y
	Chinee Apple*	*Ziziphus mauritiana*	A/C	
	Mimosa*	*Mimosa pigra*	A/C	Y
	Bellyache Bush*	*Jatropha gossypiifolia*	A/C[3]	Y
	Gamba Grass*	*Andropogon gayanus*	A/C	Y
	Neem*	*Azadirachta indica*	B/C	
	Grader grass*	*Themeda quadrivalvis*	B/C	Y
	Snake weed	*Stachytarpheta spp.*	B/C	
	Devils Claw	*Martynia annua*	A/C	
Other declared weeds	Parthenium[4]	*Parthenium hysterophorus*	A/C	Y
	Starburr	*Acanthospermum hispidum*	B/C	
	Mossman River Grass	*Cenchrus echinatus*	B/C	
	Spiny-head Sida	*Sida acuta*	B/C	

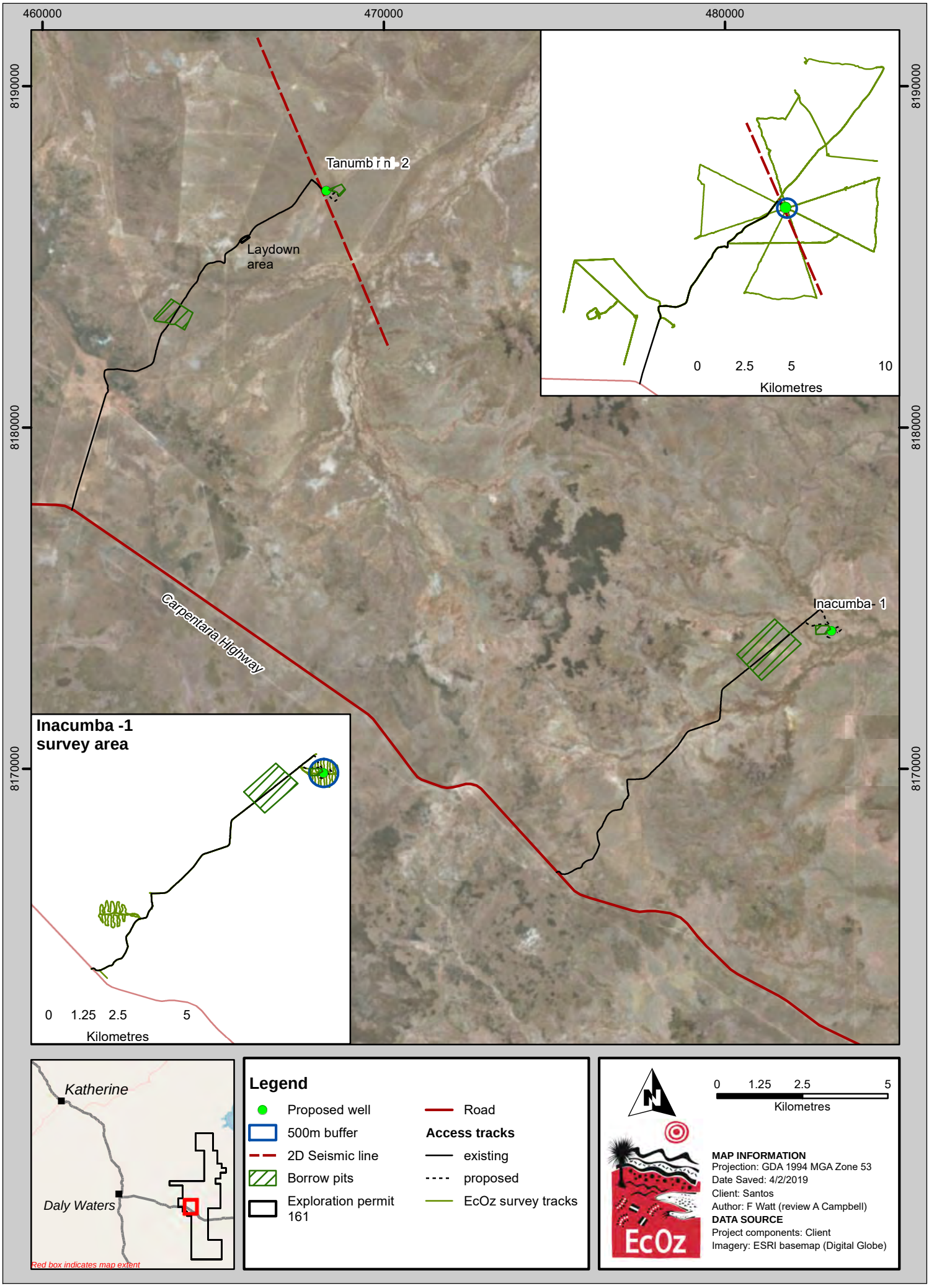
[2] Although Rubber Bush is only declared south of 16°30' S, it was included in this list as current exploration areas are just north of this latitude and the exploration permit area crosses this line of declaration

[3] Bellyache bush classification depends on its location within the NT; the EP is within the Class A eradication zone

[4] Parthenium, previously eradicated from the NT, has recently been recorded in the Katherine region

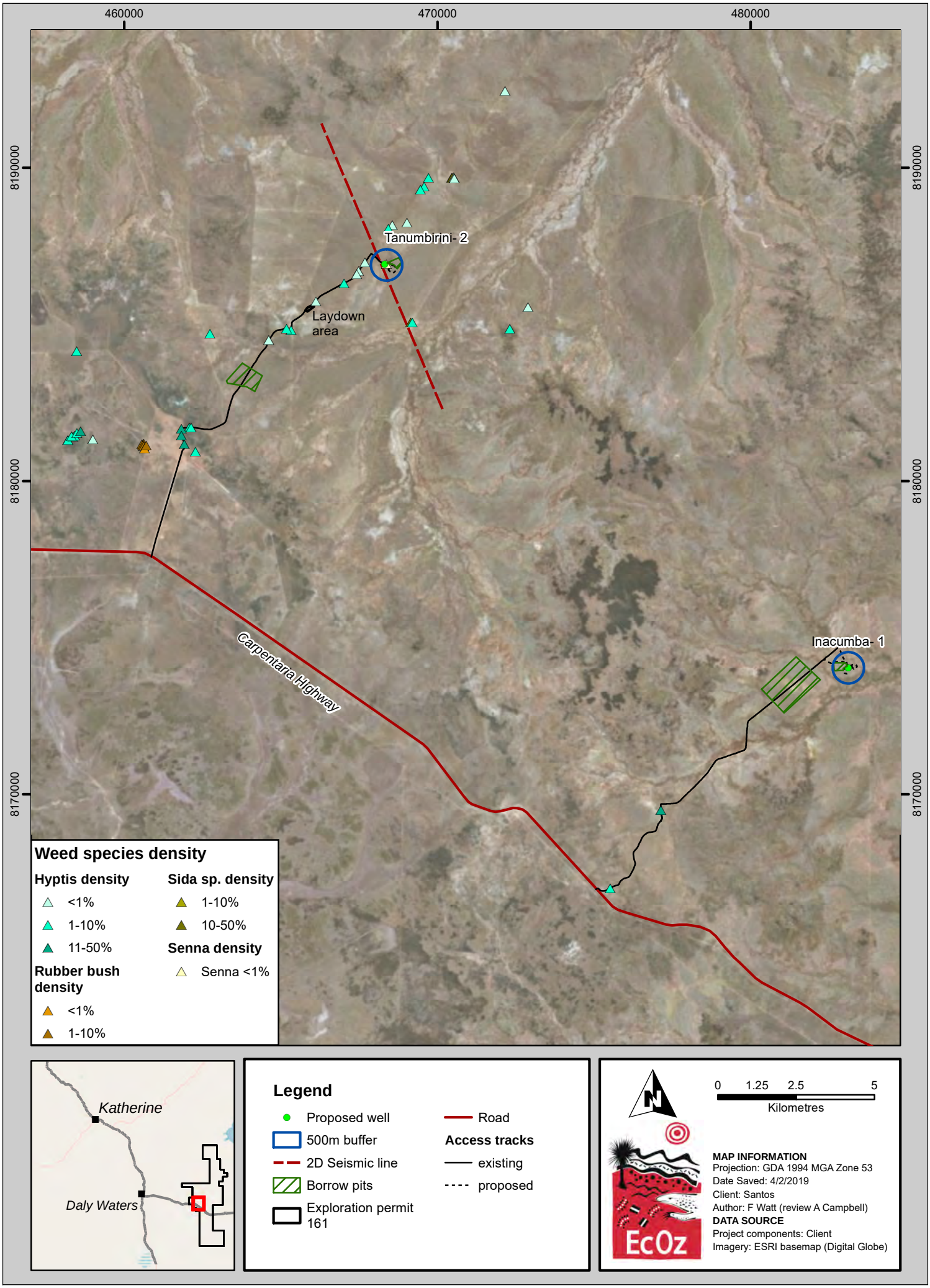
	Common name	Scientific name	NT Class	WoNS
	Flannel Weed	*Sida cordifolia*	B/C	
	Paddy`s Lucerne	*Sida rhombifolia*	B/C	
	Caltrop	*Tribulus terrestris*	B/C	
	Noogoora Burr	*Xanthium strumarium*	B/C	
	Khaki Weed	*Alternanthera pungens*	B/C	

* indicates weeds with an associated weed management plan



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19041 - Santos EP161 EMP aspects\01 Project Files\WMP Figure 4-1. Proximity of 2019 project area to baseline surveys.mxd

Figure 2-1. Map of 2019 exploration program project area and survey area



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19041 - Santos EP161 EMP aspects\01 Project Files\WMP Figure 4-2. Location of weed occurrences within or adjacent to 2019 exploration program area.mxd

Figure 4-2. Weed occurrences within, or adjacent to, project area

5 ANNUAL ACTION PLAN

The annual action plan in Table 5-1 details the survey and control activities for weeds recorded within EP 161.

Table 5-1. Annual action plan

Weed Management Area	Weed species	Management objective	Survey / monitoring time/s	Treatment time/s	Control method/s	Herbicide
Tanumbirini- 2	Sicklepod	No spread	End of wet season – March depending on site access	End of wet season – March depending on site access	Foliar spray seedlings and adults	Dicamba 500 g/L Rate: 500mL/100 L
	Hyptis	No spread	End of wet season – March depending on site access	End of wet season – March depending on site access	Foliar spray seedlings and adults	2, 4-D amine 625 g/L Rate: 320 mL/100 L
Laydown area	Hyptis	No spread	End of wet season – March depending on site access	End of wet season – March depending on site access	Foliar spray seedlings and adults	2, 4-D amine 625 g/L Rate: 320 mL/100L
Tanumbirini Borrow Pit	No weeds	Prevent the introduction of weeds	End of wet season – March depending on site access	Immediately if weeds are found	Refer to the NT Weed Management Handbook	
2D Seismic line	Hyptis	No spread	End of wet season – March depending on site access	End of wet season – March depending on site access	Foliar spray seedlings and adults	2, 4-D amine 625 g/L Rate: 320 mL/100L
	Sicklepod	No spread	End of wet season – March depending on site access	End of wet season – March depending on site access	Foliar spray seedlings and adults	Dicamba 500 g/L Rate: 500mL/100 L
Tanumbirini	Spinyhead sida	No spread	End of wet season – March depending on site	End of wet season – March depending on	Foliar spray seedlings and	2, 4-D amine 625

Weed Management Area	Weed species	Management objective	Survey / monitoring time/s	Treatment time/s	Control method/s	Herbicide
Access tracks			access	site access	adults	g/L Rate: 320 mL/100 L
	Hyptis	No spread	End of wet season – March depending on site access	End of wet season – March depending on site access	Foliar spray seedlings and adults	2, 4-D amine 625 g/L Rate: 320 mL/100L
	Rubber Bush	No spread	End of wet season – March depending on site access	End of wet season – March depending on site access	Foliar spray seedlings	Triclopyr 300 g/L Rate: 750 mL/100 L (water)
					Basal Bark <5 cm stems – spray to point of runoff Cut stump > 5 cm stems	Triclopyr 240 g/L + Picloram 120 g/L 1 L/60 L (diesel)
Inacumba-1	No weeds	Prevent the introduction of weeds	End of wet season – March depending on site access	Immediately if weeds are found	Refer to the NT Weed Management Handbook	
Inacumba Access Tracks	Hyptis	No spread	End of wet season – March depending on site access	End of wet season – March depending on site access	Foliar spray seedlings and adults	2, 4-D amine 625 g/L Rate: 320 mL/100L
Inacumba Borrow Pit	No weeds	Prevent the introduction of weeds	End of wet season – March depending on site access	Immediately if weeds are found	Refer to the NT Weed Management Handbook	

Treatment times, control methods and herbicide application rates have been taken from the NT Weed management handbook

6 WEED MONITORING

The requirements for weed monitoring within each component of the project area are outline above in Section 5. Additional to the survey / monitoring times listed in Table 5-1, monitoring for weed incursions will be ongoing during operations, as all operational staff will have a responsibility to report new weed incursions to Santos' dedicated weed officer. Should new weed incursions be identified during the initial survey and monitoring, follow-up surveys will be within three months to ensure effective eradication of the incursions.

Upon commencement of construction, access to the proposed exploration wells will be restricted to approved access tracks. Once constructed, the potential for weed spread within the project area should be largely reduced to access tracks, the 2D seismic line and exploration well infrastructure. To target survey efforts within areas at high risk of weed establishment, weed monitoring will focus on the following areas:

- Known weed locations
- Along access tracks
- 2D seismic line
- Borrow pits and laydown areas
- 50 m buffer around stock watering points traversed by access tracks
- 50 m buffer around exploration wells
- Any other areas that were disturbed during track, seismic line or well construction process

6.1 Notification procedure

All new weed incursions will be reported to the NT Weed Management Branch by Santos' dedicated weed officer. Initial notification will be verbal, followed by written notification of preliminary species identification and location within seven working days.

6.2 Recording

All weed monitoring and survey activities will be recorded in accordance with the NT Weed Data Collection Guidelines available at: https://nt.gov.au/environment/weeds/weed-mapping-and-data-sharing.

The following attributes of any new weed infestations will be recorded into a GPS enabled device:

- Site ID
- Weed name
- ID confidence
- Date of record
- Coordinate information
- Recorder / organisation
- Infestation size
    - 20 m diameter
    - 50 m diameter
    - 100 m diameter
- Infestation density
    - 1 = Absent, no weeds of this species in the area
    - 2 = < 1%; very few, not many weeds
    - 3 = 1 – 10%; more than one or two isolate plants
    - 4 = 11 – 50%; Many plants, covering up to half the area
    - 5 = > 50%; Weed forms the dominant cover

Weed data will be submitted as an excel spreadsheet to the Weeds Management Branch (refer Appendix C for an example template)

6.3 Reporting

Santos' weed management officer will submit annual reporting against this WMP as a component of environmental reporting requirements. This will include

- Details of activities implemented to address weed spread and introduction risks
- Submission of all weed data collected
- Details of survey and monitoring events, including dates, personnel, maps and track data
- An overview of weed control events and success rates

This annual report will be reviewed by the NT Government's Onshore petroleum weed management officer.

7 REFERENCES

Weed Management Branch 2015a, *Northern Territory Weed Management Handbook*, Department of Land Resource Management, Northern Territory Government, Darwin

Weed Management Branch 2015b, *Northern Territory Weed Data Collection Manual*, Department of Land Resource Management, Northern Territory Government, Darwin

APPENDIX A SANTOS CORPORATE ENVIRONMENTAL POLICY

Environment, Health and Safety

Santos

Policy

Our Commitment

Santos is committed to a workplace where we all go home without injury or illness and manage the impact of our operations on the environment.

Our Actions

We will:

1. implement a structured and systematic approach to environmental, health and safety management and monitor its effectiveness
2. include environmental, health and safety considerations in business planning and decision-making processes
3. understand and manage the impact of our operations on the environment
4. comply with all relevant environmental, health and safety laws
5. promote a strong and consistent safety culture across all aspects of business
6. work pro-actively and collaboratively with our stakeholders and the communities in which we operate
7. set, measure and review objectives and targets which drive continuous improvement
8. report publicly on our environmental, health and safety performance

Governance

The Environment Health Safety & Sustainability Committee is responsible for reviewing the effectiveness of this policy.

This Policy will be reviewed at appropriate intervals and revised when necessary to keep it current.

Kevin Gallagher

Managing Director & CEO

Status: APPROVED

Document Owner:	Naomi James, Executive Vice President, EHS & Governance		
Approved by:	The Board	Version:	1

APPROVED 28 October 2016

Page 1 of 1

Weed Hygiene Declaration

This declaration is valid for transport and movement of vehicles and equipment from _____ to _____ (provide locations) and will stay current pursuant to the definition of clean in Definitions.

VEHICLE DESCRIPTION

Make: _____ Registration # or engine number: _____

Was clean prior to entry to _____ (destination)

Add equipment examined to the Equipment Register

Certifier name _____

Certifier qualification _____ Qualification date _____

DECLARATION

I, _____ (name),of _____ (street)

_____ town _____ state _____ telephone

declare the information I provided in this declaration is true and correct and I have read the accompanying explanatory notes before completion of this declaration.

Signature _____ Date _____

EXPLANATORY NOTES

This certification process was developed to fulfill one of the stated purposes of the NT *Weed Management Act* and the Qld Land Protection *(Pest and Stock Route Management) Act 2002*.

It applies to, as a minimum, all weeds listed as weeds in the relevant jurisdiction and any plants that a stakeholder does not want transported or introduced.

DEFINITIONS

Clean:

- Means that no soil or organic matter is present on vehicles or equipment
- Vehicles and equipment are considered clean if, after certified weed free, it does not touch soil or vegetative material, ie for a vehicle this means it travels on sealed or well-maintained unsealed roads.

Equipment means anything other than a vehicle.

Vehicle includes anything used for carrying a thing or person by land, water or air.

Weed reproductive material means any part of a plant that is capable of producing another plant by sexual or asexual means. This includes seeds, bulbs, rhizomes, tuber, stem, leaf cuttings or a whole plant.

Well-maintained unsealed road means roads that do not have vegetation growing on or encroaching onto the area occupied by traffic.

Checklist-Cars, 4WD, trucks and trailer

INTERIOR	**Pass** ☐	**Fail** ☐
• Inspect foot wells • Inspect under mats and carpet as well as the pile of carpet		
BOOT OR TRAY	**Pass** ☐	**Fail** ☐
• Inspect under mats or carpet • Inspect inside spare tyre area/behind spare tyre • Inspect other recesses in the boot/rear of the vehicle • Inspect recess of boot lid		
ENGINE BAY	**Pass** ☐	**Fail** ☐
Inspect all areas of the engine bay with a particular focus on areas listed below • Inspect the radiator • Inspect the grill • Inspect the top of transmission gearbox • Inspect the recess under windscreen wipers • Inspect air filter box		
UNDERSIDE OF VEHICLE	**Pass** ☐	**Fail** ☐
• Inspect the wheel arches, wheel trims, flares, step treads, bumpers • Inspect the mud flaps • Inspect the tyre rims (particularly the rear side) • Inspect the top of axels and differentials • Inspect the top of muffler and surrounds • Inspect the spare tyres on 4WDs and station wagons (they are often suspended underneath). Remove to check • Inspect top side of any bash plates **Note:** these are potentially a high risk area as contaminants collect inside the horizontal positioned rim of the spare tyre.		
CARGO	**Pass** ☐	**Fail** ☐
• Inspect all equipment, list in the equipment register below		
FOR UTILITIES AND TRUCKS	**Pass** ☐	**Fail** ☐
• Inspect the floor of the tray. Inspect channels of tail gates and tray drop sides • Inspect side guards. • Inspect under chassis rails, including within steel sections • Inspect the gaps in the floor welds or boards and bolt holes on tray.		
TRAILERS	**Pass** ☐	**Fail** ☐
• Inspect wheels • Inspect guards and trays • Inspect channels and draw bar • Inspect underbody		

APPENDIX C WEED CONTROL RECORDING TEMPLATE

RECORDER		Fred Smith		Location or Project Name:										
ORGANISATION NAME		Weed Terminators NT		Recorder Method:				E.g. High precision GPS						
Your reference	eg. 2/11/2006	Set the Datum on your GPS receiver to WGS84 or GDA94 using decimal degrees Lat: -14.56341 Long: 132.34521		Common name	5, 20, 50, 100, 200	1,2,3,4,5	Use list	Yes, No, Not recorded			use list	use list		
WAYPOINT (SITE_ID)	DATE_REC	LAT_G94	LONG_G94	WEED_NAME	SIZE_DIA_M	DENS_CAT	TREATMENT	Seedlings	juveniles	adults	HERBICIDE	SEED_PRES	COMMENTS	
006	*13/08/2015*	*132.31142*	*-14.51862*	*Athel Pine*	*5*	*2*	*Stem injection*	*No*	*No*	*Yes*	*Triclopyr 600g/*	*Not recorded*	*Example only*	

EcOz Pty Ltd.
ABN 81 143 989 039

Winlow House, 3rd Floor
75 Woods Street
Darwin NT 0800

GPO Box 381,
Darwin NT 0800

T: +61 8 8981 1100
F: +61 8 8981 1102
E: ecoz@ecoz.com.au

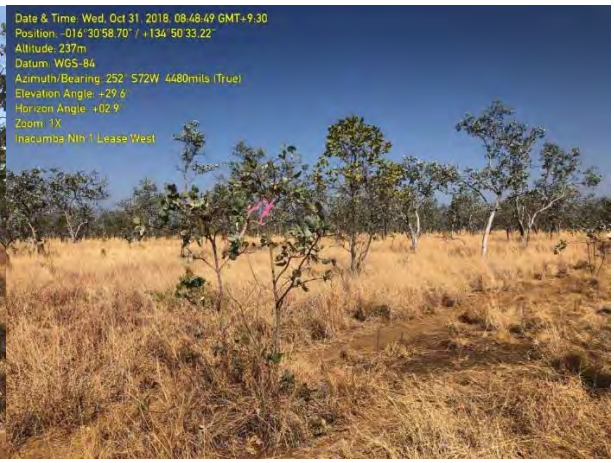
www.ecoz.com.au

Appendix G: Site Photos

Photos of the Tanumbirini-1/2H and the Inacumba-1/1H locations

Inacumba

Inacumba_1/1H Leasepad



Vegetation along the watercourse

Riparian vegetation to the south (left) and drainage line vegetation (right) running from the north to south-east of the Inacumba-1 well

Inacumba Access Road Option 1 and 2 creek crossings

Chainage 1.2 drainage line crossing (left) and Chainage 3.2 drainage line crossing (right)

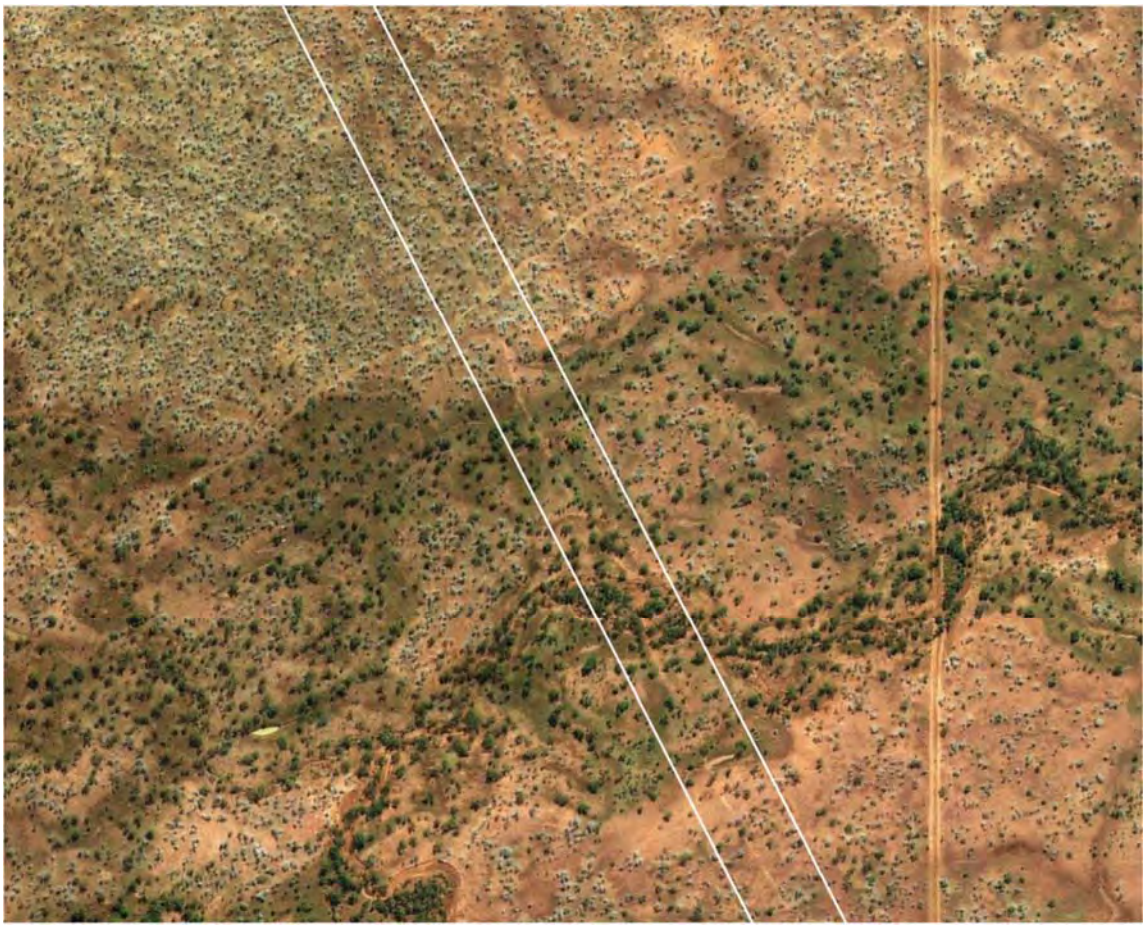
Chainage 5.4 drainage line crossing (left) and chainage 5.6-5.7 floodway area (right)

Chainage 6.7 drainage line crossing and chainage 10.5 drainage line crossing

Tanumbirini 1/2H location

Drainage line vegetation along transects from Tanumbirini 1/2H location

Aerial Photo of previous seismic line at Tanumbirini



Appendix H: Stakeholder Engagement Records

Table H-1: List of Relevant Stakeholders

Stakeholder	Role/Position	Phone number	Email or other contact
Aboriginal Affairs Protection Authority			
	Chief Executive Officer (CEO) AAPA		
Landholders/Managers			
	Tanumbirini Station Manager		
	Beetaloo / O.T Downs Station Manager		
	Broadmere Station Manager		
Northern Land Council			
	Manager Minerals and Energy		
Northern Territory Government			
	Executive Director – Onshore Gas Reform (DENR)		
	Executive Director (DPIR)		
	DENR		
	Senior Onshore Petroleum Advisor		
	Senior Assessment Officer - Petroleum		

	Regional Weed Officer (Onshore Shale Gas Development) – DENR		

Table H-2: Stakeholder Engagement Records

Stakeholder	Role / Position	Date	Type of Contact	Method of Contact	Matters Raised	Santos Response (If required)
	Tanumbirini Station Managers	1-2 Feb 2019	Face to face	Consultation	Accompanying CSIRO crew conducting methane survey	
	Thames Pastoral	25 Jan 2019	Email	Consultation	Completed Santos 2018 activities and initiate engagement for Santos plans for 2019 and requirement for LACA	
	Tanumbirini Station Managers	24 Jan 2019	Email	Notice of entry	EP 161 CSIRO Methane Survey Activity	
	Tanumbirini Station Managers	18-20 Dec 2018	Face to face	Consultation	Close out 2018 Santos activities and face to face conversation about Santos plans for 2019	
	Tanumbirini Station Managers	19 Oct 2018	Email	Notice of Entry	2019 Beetaloo Drilling Program Scout EP 161	
	Tanumbirini Station Managers	18 Oct 2018	Email	Consultation	Ongoing communication regarding accommodation requirements at Tanumbirini Station	
	Tanumbirini Station Managers	15 Oct 2018 /16 Oct 2018	Email	Consultation	Accommodation requirements/availability at Tanumbirini Station	

Stakeholder	Role / Position	Date	Type of Contact	Method of Contact	Matters Raised	Santos Response (If required)
	Tanumbirini Station Managers	15 Oct 2018	Email	Notice of Entry	EP 161 Water Bore Baseline Monitoring	
	Tanumbirini Station Managers	Oct 2018-Jan 2019	Phone calls and text messages	Consultation	Numerous phone calls and text messages regarding Santos activities – survey, accommodation, contractor camp, civil activities for bore drills	
	Tanumbirini Station Managers	24/10/2018 / 23/10/2018 / 22/10/2018	Face to face/ Email / Email	Consultation	Daily contact onsite on Tanumbirini Station regarding requirements to access bores, fuel equipment etc.	
	Beetaloo Station Managers	25/10/2018 / 24/10/2018	Face to face/ Email	Consultation	Met onsite on Beetaloo Station regarding requirements to access bores and planned activity.	
	Tanumbirini Station Managers	16/10/2018 / 15/10/2018	Email	Communication	Correspondence regarding CSIRO and Santos representatives conducting bore monitoring and accommodation requirements	
	Broadmere Station Managers	17/10/2018/ 15/10/2018	Email	Communication	Update on Beetaloo groundwater monitoring program	
	Tanumbirini Station Managers	19/10/2018	Email	Notice of Entry	Survey and Scout for 2019 Beetaloo Drilling Program	
	Beetaloo / O.T Downs Managers	15/10/2018	Email	Notice of Entry	Beetaloo - Groundwater monitoring EP 161	

Stakeholder	Role / Position	Date	Type of Contact	Method of Contact	Matters Raised	Santos Response (If required)
	Tanumbirini Station Managers	15/10/2018	Email	Notice of Entry	Tanumbirini - Groundwater monitoring EP 161	
	Tanumbirini Station Managers	6/10/2018	Email	Notice of Entry	2018 Work Program Tanumbirini – Survey	
	Broadmere Station Managers	29/08/2018	Email	Notice of Entry	Beetaloo groundwater monitoring program	
	Tanumbirini Station Managers	12/08/2018 11/08/2018 10/08/2018 09/08/2018 08/08/2018 07/08/2018	Face to face	Consultation	Daily contact onsite on Tanumbirini Station regarding requirements to access bores, fuel, equipment and updates on progress etc.	
	Beetaloo / O.T Downs Managers	24/04/2018	Email	Notice of Entry	Beetaloo groundwater monitoring program	
	Tanumbirini Station Managers	24/04/2018	Email	Notice of Entry	Beetaloo Groundwater Monitoring Program	