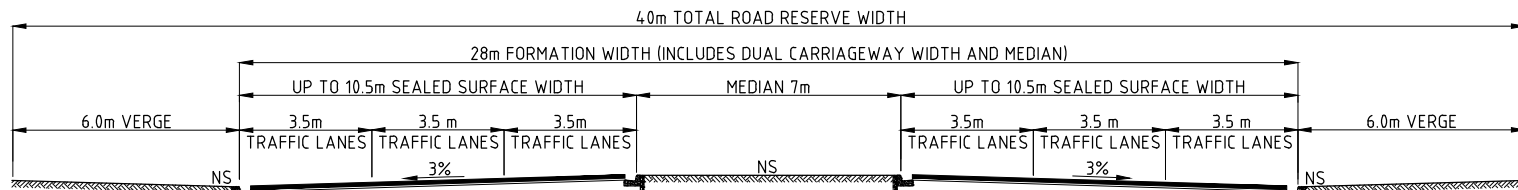


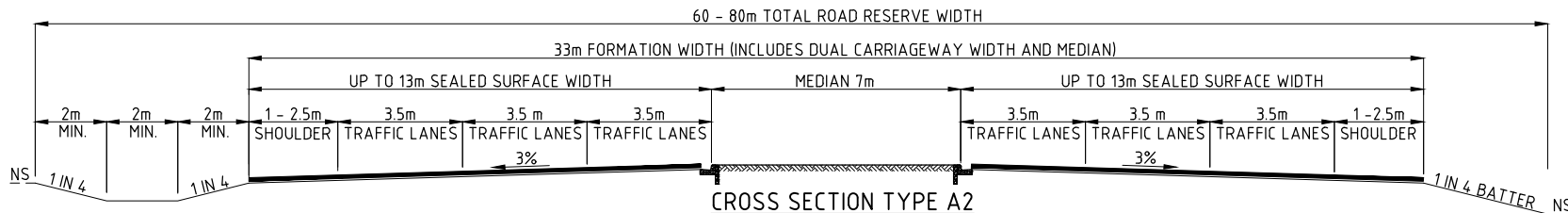
**Appendix A Typical Cross Sections For Urban and Rural Environments (NTG,  
Sept 2017)**



**NOTE:**

KERB SIDE LANE TO BE MINIMUM 5.0m WIDE DURING STAGE CONSTRUCTION

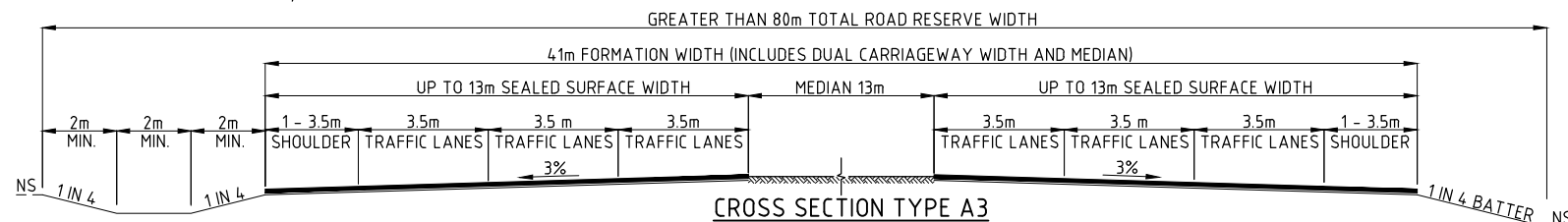
**CROSS SECTION TYPE A1  
URBAN - PRIMARY ARTERIALS**



**CROSS SECTION TYPE A2  
SEMI-URBAN - PRIMARY ARTERIALS**

**NOTE:**

TOTAL ROAD RESERVE WIDTH 60 - 80m TO ALLOW FOR SIDE DRAINS AND POSSIBLE SERVICES. SHOULDERS TO BE SEALED, MINIMUM 1.0m.



**CROSS SECTION TYPE A3  
RURAL - PRIMARY ARTERIALS**

**URBAN ENVIRONMENT**

TYPICAL CROSS SECTIONS - URBAN ENVIRONMENT							
ROAD CLASSIFICATION	AUSTRROAD CLASS	TYPE CROSS SECTION	FORMATION (DUAL CARRIAGEWAY)	TRAFFIC LANES		SEAL WIDTH (m)	COMMENTS
				WIDTH (m)	SURFACE		
URBAN - PRIMARY ARTERIALS:							
URBAN	CLASS 6	TYPE A1	28.0	UP TO 3 x 3.5	SEALED	UP TO 10.5 EACH WAY	KERB SIDE LANE TO BE MINIMUM 5.0m WIDE DURING STAGE CONSTRUCTION. TOTAL ROAD RESERVE WIDTH 40m
SEMI - URBAN	CLASS 6	TYPE A2	33.0	UP TO 3 x 3.5 EACH WAY	SEALED	UP TO 13.0 EACH WAY (INC.FULL WIDTH SHOULDER SEAL)	SHOULDER TO BE SEALED MINIMUM 1.0m. TOTAL ROAD RESERVE WIDTH 60 -80m TO ALLOW FOR SIDE DRAINS AND POSSIBLE SERVICES.
RURAL	CLASS 6	TYPE A3	41.0	UP TO 3 x 3.5 EACH WAY	SEALED	UP TO 14.0 EACH WAY (INC.FULL WIDTH SHOULDER SEAL)	SHOULDER TO BE SEALED MINIMUM OF 1.0m. PAVEMENT & SEAL TO EXTEND A MINIMUM OF 1.0m IN TO THE MEDIAN. TOTAL ROAD RESERVE WIDTH GREATER THAN 80m

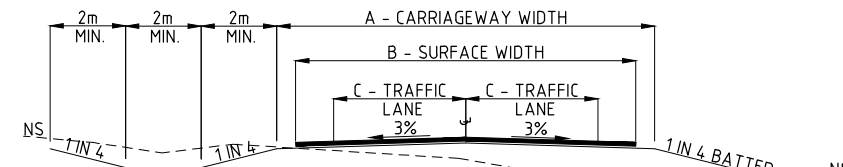
TABLE AS PER THE DEPARTMENT'S POLICY FOR STANDARD ROAD CROSS SECTIONS - APRIL 2015 - VERSION 1.0

**URBAN ENVIRONMENT NOTES:**

- REFER TO LOCAL GOVERNMENT GUIDELINES FOR URBAN SUB ARTERIALS (6000-12000 VPD), URBAN DISTRIBUTOR (LESS THAN 6000 VPD) AND URBAN COLLECTOR (LESS THAN 3000 VPD) ROADS.
- REFER TO DEPARTMENT GUIDELINES FOR URBAN LOCAL AND URBAN SUBDIVISION REQUIREMENTS.

**GENERAL NOTES:**

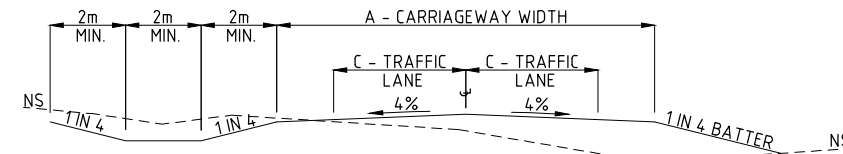
- REFER TO STANDARD DRAWING CS3002 FOR SHEET 1.



**NOTE:**

PAVEMENT AND SEAL TO EXTEND A MINIMUM OF 1.0m IN TO THE MEDIAN. SHOULDERS TO BE SEALED, MINIMUM 1.0m.

**CROSS SECTION TYPE B  
RURAL SEALED ROADS**



**CROSS SECTION TYPE C  
RURAL UNSEALED ROADS**

**RURAL ENVIRONMENT**

TYPICAL CROSS SECTIONS - RURAL ENVIRONMENT							
ROAD CLASSIFICATION	AUSTRROAD CLASS	TYPE CROSS SECTION	CARRIAGEWAY WIDTH (m) (INCLUDING MEDIAN)	TRAFFIC LANES		SEAL/ GRAVEL WIDTH (m)	COMMENTS
				WIDTH (m)	SURFACE		
RURAL - NATIONAL HIGHWAY	CLASS 1	TYPE B	11.0	2 x 3.5	SEALED	8.0	NATIONAL STANDARDS UNDER REVIEW. SEAL WIDTH MAY BE INCREASED TO 9.0m DEPENDING ON LOCAL ISSUES
RURAL ARTERIAL	CLASS 3	TYPE B	10.0	2 x 3.5	SEALED	8.0	> 1000 VPD - 20 YEAR PROJECTED VOLUMES, SEE NOTE 1
RURAL SECONDARY ROADS	CLASS 4	TYPE B	9.0	2 x 3.0	SEALED	7.0	< 500 VPD - 20 YEAR PROJECTED VOLUMES, SEE NOTE 1
RURAL SECONDARY ROADS	CLASS 4	TYPE C	9.0	2 x 3.0	GRAVELLED	6.0	SEE NOTE 2
RURAL - LOCAL	CLASS 5	TYPE B	9.0	2 x 3.0	SEALED	7.0	FOR UNSEALED ROADS A 9.0m CARRIAGEWAY MAY BE APPROPRIATE IF FUTURE SEALING IS FORESEEABLE. SEE NOTE 2.
		TYPE C	8.0	2 x 3.0	GRAVELLED	6.0	
RURAL - SUBDIVISIONS	REFER TO CS3002						REFER TO DEVELOPMENT GUIDELINES BY THE TRANSPORT INFRASTRUCTURE PLANNING DIVISION.
PASTORAL ACCESS ROADS							
PASTORAL 1	CLASS 5	TYPE C	4.0	1 x 4.0	FORMED	-	SINGLE USER ACCESS
PASTORAL 2	CLASS 5	TYPE C	6.0	1 x 6.0	FORMED	-	MULTI USER ACCESS FOR UP TO 3 PROPERTIES
PASTORAL 3	CLASS 5	TYPE C	8.0	2 x 3.0	GRAVELLED	6.0	PROVIDES ACCESS TO GREATER THAN 3 PROPERTIES

TABLE AS PER THE DEPARTMENT'S POLICY FOR STANDARD ROAD CROSS SECTIONS - APRIL 2015 - VERSION 1.0

**RURAL ENVIRONMENT NOTES:**

- FOR PREDICATED FUTURE VOLUMES OF 500 - 1000 VPD THE STANDARD WILL DEPEND ON TRAFFIC MIX (NUMBERS OF ROAD TRAINS/CARAVANS/BUSES) AND TOPOGRAPHY AND WILL BE ASSESSED ON A CASE BY CASE BASIS. SEAL WIDTHS MAY ALSO BE INCREASED DEPENDING ON LOCAL ISSUES SUCH AS SEASONAL VARIATIONS (TOURISM) AND ENVIRONMENT.
- THE DECISION IN REGARD TO SEALED VERSUS GRAVEL STANDARD FOR A PARTICULAR ROAD WILL DEPEND ON FACTORS SUCH AS PROPOSED USE (I.E HORTICULTURAL), ENVIRONMENT, PREDICTED USE AND THE LIKE AND SHOULD BE REFERRED TO TRANSPORT INFRASTRUCTURE PLANNING DIVISION.

No.	DESCRIPTION	DATE	NAME	DEPT/COMPANY
1	TABLE DETAILS AMENDED	MAR 2019	S.SHI	EES/ DIPL
0	ISSUED AS A STANDARD DRAWING	SEPT 2017	J.LEESON	EES/DIPL
AMENDMENTS				

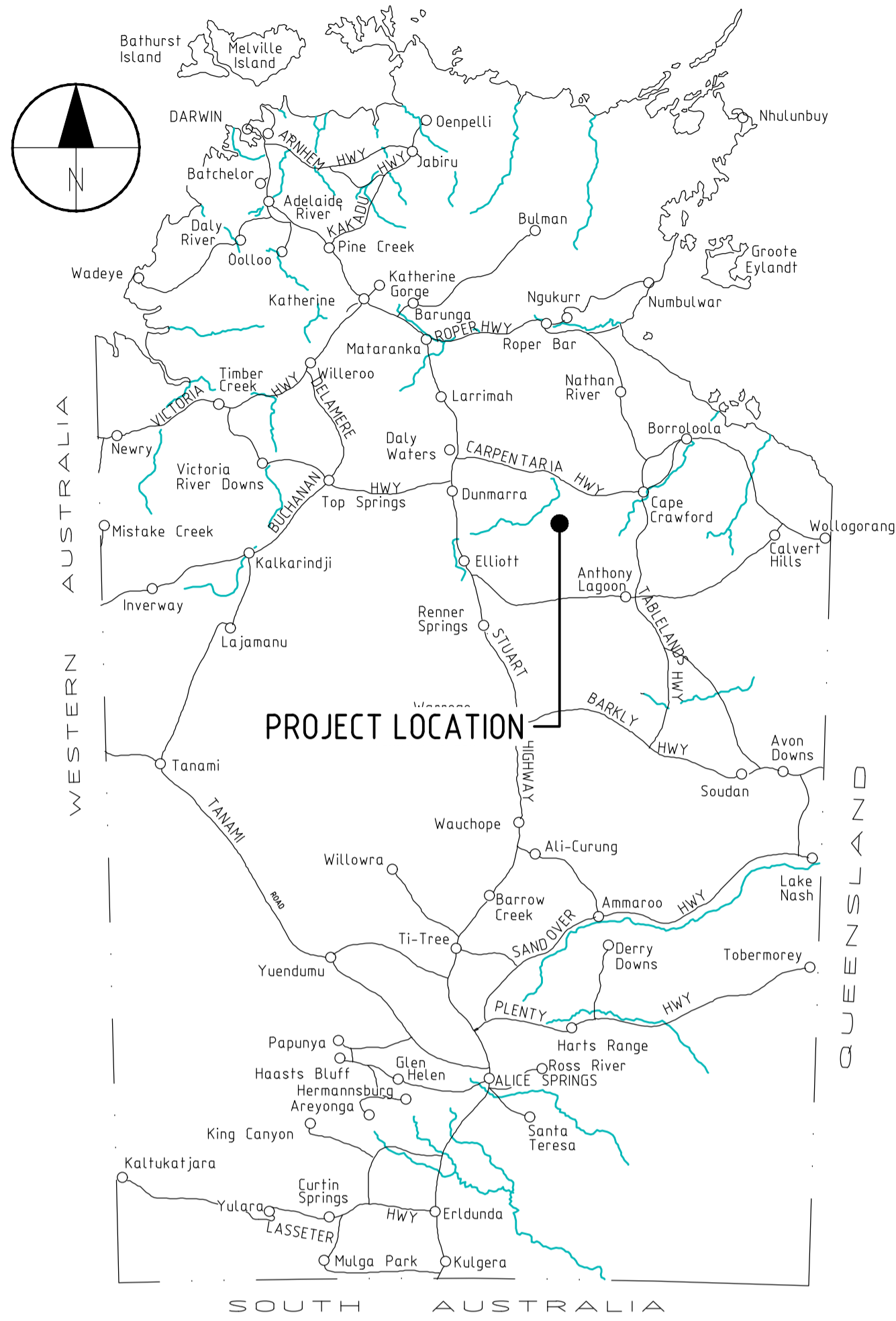
**WARNING**  
BEWARE OF UNDERGROUND SERVICES. THE LOCATIONS OF UNDERGROUND SERVICES ARE APPROXIMATE ONLY AND THEIR EXACT POSITION SHOULD BE PROVEN ON SITE. NO GUARANTEE IS GIVEN THAT ALL EXISTING SERVICES ARE SHOWN.

DRAWN J.LEESON	CHECKED S.HATZI
DATE MAR 2017	DATE MAR 2017
DESIGNED J.LEESON	CHECKED S.HATZI
DATE MAR 2017	DATE MAR 2017
DESIGN LEADER S.HATZI	DESIGN DIRECTOR S.JACKSON
DATE 1/09/2017	DATE 1/09/2017

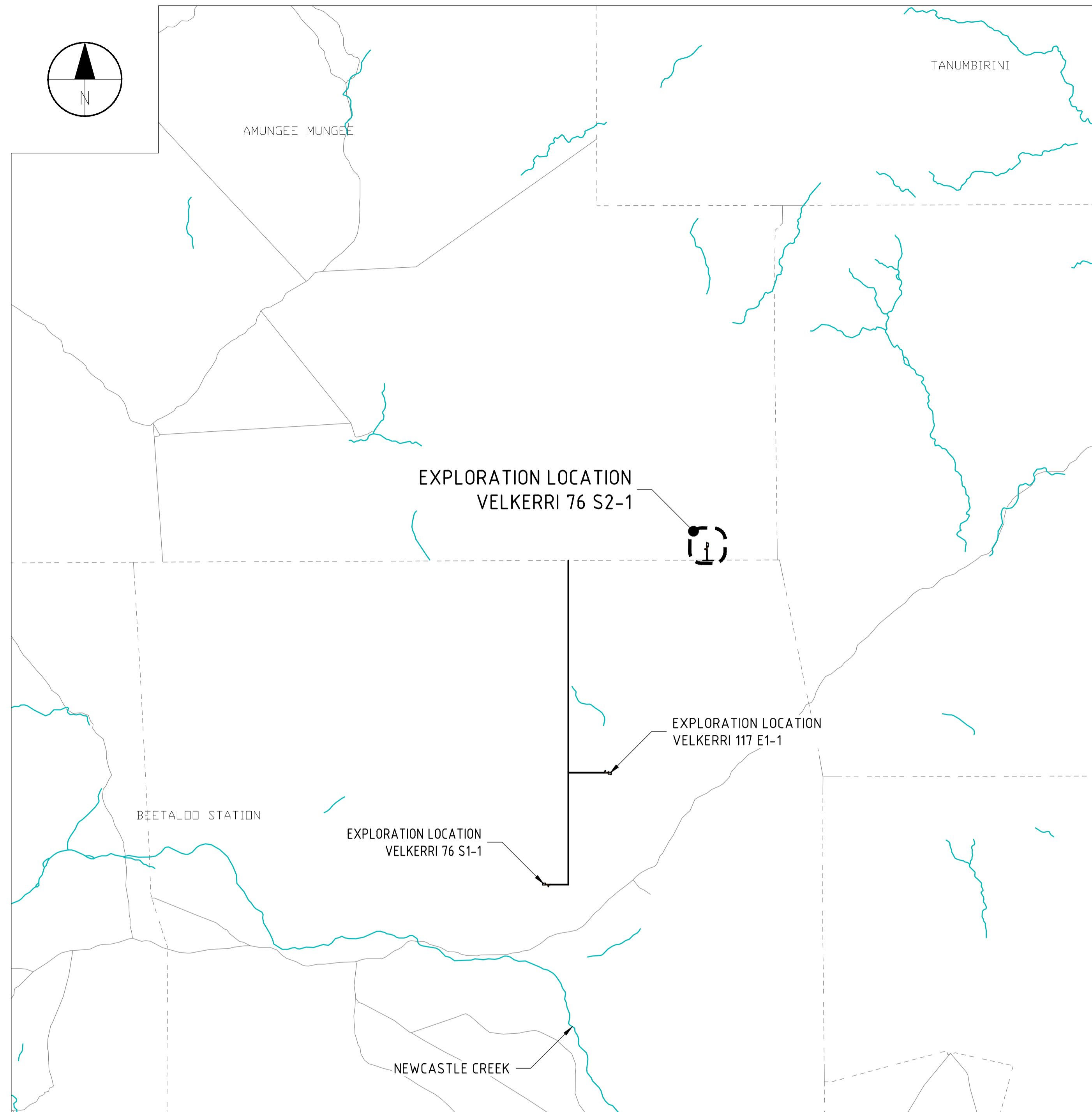
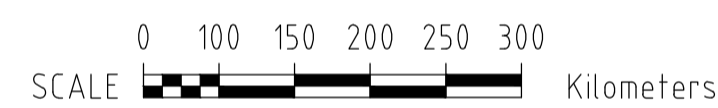


STANDARD DRAWINGS TYPICAL CROSS SECTIONS				
<b>TYPICAL CROSS SECTIONS FOR URBAN AND RURAL ENVIRONMENTS</b>				
FILE No.	ASSET No.	SHEET No.	DRAWING No.	AMEND.
-	-	2 OF 2	CS3003	1
				SHEET SIZE A1

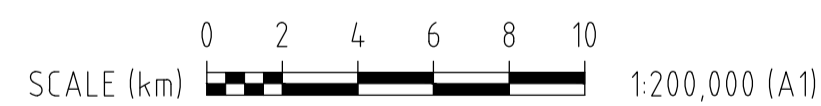
**Appendix B Infrastructure Design Drawings**



**LOCALITY MAP**



**LOCALITY PLAN**



DRAWING SCHEDULE	
CIVIL	
DRAWING NUMBER	DESCRIPTION
NT-2050-20-DH-0007	LOCALITY MAP, LOCALITY PLAN, DRAWING SCHEDULE, GENERAL NOTES
NT-2050-20-DA-0023	DRILL PAD, ACCOMODATION CAMP AND WATER TANK GENERAL ARRANGEMENT PLAN
NT-2050-20-DA-0026	DRILL PAD, ACCOMODATION CAMP AND WATER TANK EARTHWORKS GENERAL ARRANGEMENT PLAN
NT-2050-20-DD-0023	DESIGN DETAILS
NT-2050-20-DD-0031	MUD SUMP DETAILS
NT-2050-20-DD-0025	PAD ACCESS ROAD
NT-2050-20-DD-0032	PAD INTERSECTION DETAIL
NT-2050-20-DD-0027	DRILLING CELLAR DETAILS
NT-2050-15-MP-0022	DRILL PAD, ACCOMODATION CAMP AND WATER TANK EROSION AND SEDIMENT CONTROL PLAN
STANDARD DRAWINGS	
(C)S310	STOCK FENCE DESIGN AND DETAILS

**LEGEND**

EXISTING	PIPELINE
---	FENCE
---	PRINCIPAL ROAD
---	UNSEALED TRACK
---	WATERCOURSE

**GENERAL NOTES**

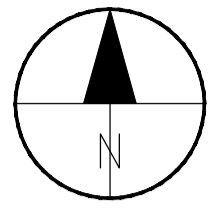
- ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
- ALL WORKS TO BE CARRIED OUT IN ACCORDANCE WITH THE APPROVED MANAGEMENT PLAN REQUIREMENTS.
- NO CONSTRUCTION WORKS ARE TO BE CARRIED OUT OUTSIDE THE APPROVED WORK CORRIDOR BOUNDARIES.
- CONSTRUCTION FACILITY AREA LOCATIONS TO BE APPROVED BY THE SUPERINTENDENT PRIOR TO WORKS COMMENCING.
- THE CONTRACTOR IS TO LIAISE WITH SERVICE PROVIDERS AND THE RELEVANT AUTHORITIES TO ENSURE ALL CONSTRUCTION WORKS ARE CARRIED OUT IN ACCORDANCE WITH SERVICE PROVIDERS AND RELEVANT AUTHORITIES REQUIREMENTS.
- NO SERVICES WERE PRESENT OR PROVIDED BY DBYD AT THE TIME OF DESIGN AND ARE THEREFORE NOT SHOWN, HOWEVER THE CONTRACTOR IS RESPONSIBLE FOR CONDUCTING A SEARCH PRIOR TO WORKS BEING CARRIED OUT. ANY DAMAGE TO EXISTING SERVICES IS TO BE RE-INSTATED AT THE CONTRACTORS EXPENSE.
- SIGNAGE TO BE INSTALLED PRIOR TO ROAD USE.
- THIS DRAWING MAY BE USED FOR TEMPORARY ACCESS APPLICATION TO NT ROADS.

**PRELIMINARY**

**NOT FOR CONSTRUCTION**

Thu, 18 Apr 2019 - 14:39pm P:\6048548\5 CAD\20-SHEETS\VELKERRI 76 S2-1\NT-2050-20-DH-0007.DWG Dudley, Calvin

DRAWING NO.		REFERENCE DRAWING TITLE		REV	DATE	REVISION DESCRIPTION	DRAWN	DWG CHECK	DESIGN	ENG DES CHECK	DE DRAFT DE PROJECT SUPER APPROVALS	PROJECT APPROVALS - OTHERS	 <b>AECOM</b> Australia Pty Ltd A.B.N 20 093 846 925 www.aecom.com	 Origin Energy Ltd ABN 30 000 051 696 GPO Box 148 Brisbane Qld. 4001 Ph: (07) 3858 0600 Fax: (07) 3369 7840	DRAWN BY: CD DWG CHECK: - DESIGN: - ENG DES CHECK: - DRAFT R SUPER: - PROJECT APPROVAL: -	BY: CD DATE: - TITLE: BEETALOO EXPLORATION DRILL CAMPAIGN VELKERRI 76 S2-1 LOCALITY MAP, LOCALITY PLAN, DRAWING SCHEDULE, GENERAL NOTES	PROJECT NO: DRAWING NO: MOD NO: SCALE: AS NOTED	DRAWING NO: <b>NT-2050-20-DH-0007</b> CADFILE: NT-2050-20-DH-0007.dwg	REVISION: <b>A</b> A1
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POINT No.	CAMP PAD SETOUT	
	EASTING	NORTHING
1	435827.715	8136494.945
2	435907.715	8136494.945
3	435827.715	8136414.945
4	435907.715	8136414.945

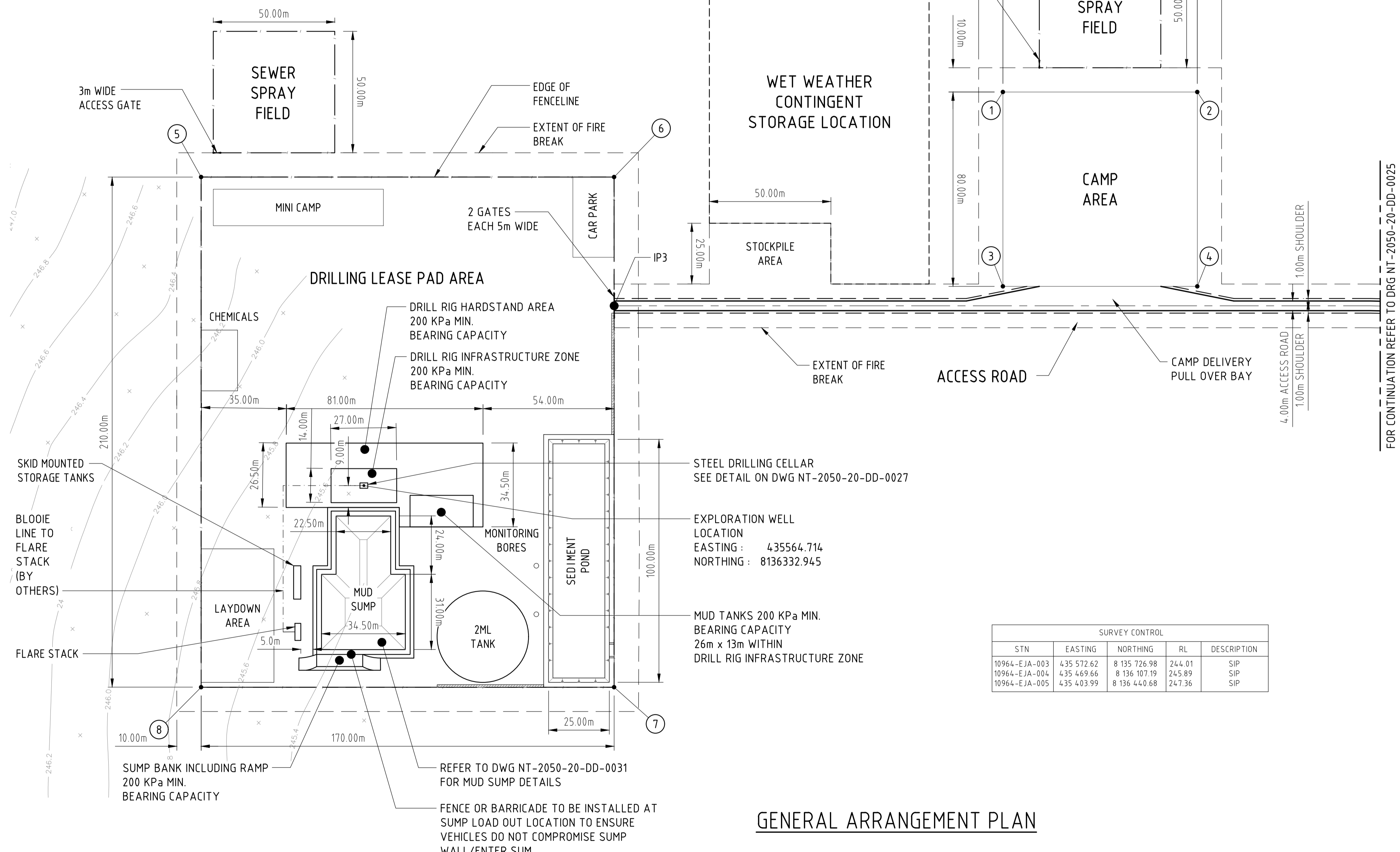
POINT No.	DRILLING LEASE PAD SETOUT	
	EASTING	NORTHING
5	435497.715	8136459.946
6	435667.715	8136459.946
7	435667.715	8136249.946
8	435497.715	8136249.946

**LEGEND**

- EXISTING
- PROPOSED
- CONTOURS
- ACCESS ROAD CENTERLINE
- EDGE OF PAVEMENT
- EDGE OF SHOULDER
- EDGE OF FOOTPATH
- EXTENT OF CLEARING - (EXTENT OF FIRE BREAK)
- EDGE OF FENCELINE

**NOTES:**

1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
2. REFER TO NORTHERN TERRITORY STANDARD DRAWING C(S)3310 FOR TYPICAL STOCK FENCE DETAILS.
3. SEWER SPRAY FIELD AREA IS NOT TO BE CLEARED. SPRAY PIPES LAID ON EXISTING VEGETATION BY OTHERS.
4. LEASE AND CAMP PAD TO BE COMPACTED TO 120KPA BEARING CAPACITY UNLESS OTHERWISE NOTED.
5. LEASE HARDSTAND PAD TO BE COMPACTED TO 200 KPA BEARING CAPACITY.
6. ALL WORKS TO BE CARRIED OUT IN ACCORDANCE WITH THE APPROVED MANAGEMENT PLAN REQUIREMENTS.
7. NO CONSTRUCTION WORKS ARE TO BE CARRIED OUT OUTSIDE THE APPROVED WORK CORRIDOR BOUNDARIES.
8. CONSTRUCTION FACILITY AREA LOCATIONS TO BE APPROVED BY THE SUPERINTENDENT PRIOR TO WORKS COMMENCING.
9. THE CONTRACTOR IS TO LIAISE WITH SERVICE PROVIDERS AND THE RELEVANT AUTHORITIES TO ENSURE ALL CONSTRUCTION WORKS ARE CARRIED OUT IN ACCORDANCE WITH SERVICE PROVIDERS AND RELEVANT AUTHORITIES REQUIREMENTS.
10. THE CONTRACTOR IS TO CARRY OUT A DBYD AND LOCATE AND MARK SERVICES ON SITE. ANY DAMAGE TO EXISTING SERVICES IS TO BE RE-INSTATED AT THE CONTRACTORS EXPENSE.
11. SIGNAGE TO BE INSTALLED PRIOR TO ROAD USE.
12. REFER TO DRAWING NT-2050-20-DD-0031 FOR MUD SUMP DETAILS AND DRAWING NT-2050-20-DD-0027 FOR STEEL DRILLING CELLAR DETAILS.
13. THE NOMINATED AREA BOUND BY SETOUT POINTS D1 TO D4 IS TO BE A UNIFORMLY GRADED PAD.
14. FINISH SURFACE LEVELS ARE TO FOLLOW EXISTING SURFACE LEVELS AS NEAR AS POSSIBLE AND TO THE GRADES SPECIFIED ON THE DRAWINGS.
15. FIREBREAK CLEARINGS AROUND DRILLING LEASE AND CAMP PAD ARE TO BE USED FOR STORAGE OF TOPSOIL AND VEGETATION AS REQUIRED.
16. FOR ROAD SETOUT TABLE REFER TO DRG. NT-2050-20-DD-0025.
17. HARDSTAND AND LEASE PAD FINISHED SURFACE LEVELS TO BE EQUAL OR SMOOTH TRANSITION TO AVOID BATTERS OF STEPS.
18. CAMP PAD AREA CROSSFALL TO BE NO GREATER THAN 1%.
19. NO ESC DEVICE CAN BE INSTALLED IN CRITICAL RIG AREA WITHOUT APPROVAL BY WELLSITE REP.
20. CATTLE PANEL FENCING TO BE INSTALLED AROUND MUD SUMP.

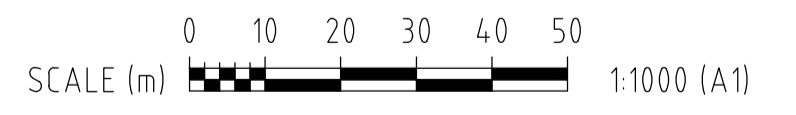


SURVEY CONTROL				
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10964-EJA-004	435 469.66	8 136 107.19	245.89	SIP
10964-EJA-005	435 403.99	8 136 440.68	247.36	SIP

**GENERAL ARRANGEMENT PLAN**

**PRELIMINARY**

**NOT FOR CONSTRUCTION**



Thu, 18 Apr 2019 - 15:00pm P:\604\X\60480548\5 CAD\20-SHEETS\VELKERRI\76 S2-1\NT-2050-20-DA-0023.DWG Dudley, Calvin

DRAWING NO.	REFERENCE DRAWING TITLE	REV	DATE	REVISION DESCRIPTION	DRAWN	DWG CHECK	DESIGN	ENG DES CHECK	DE DRAFT DE PROJECT APPROVALS	SUPER APPROVAL	PROJECT APPROVALS - OTHERS	DRAWING OFFICE	BY	DATE	TITLE	REVISION
NT-2050-20-DD-0027	DRILLING CELLAR DETAILS															
NT-2050-20-DD-0023	DESIGN DETAILS	A	21.03.2019	PRELIMINARY ISSUE												

PREPARED FOR ORIGIN BY:

**AECOM**

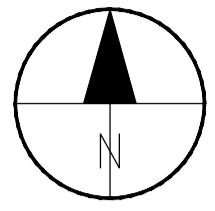
AECOM Australia Pty Ltd  
A.B.N 20 093 846 925  
www.aecom.com

**origin**

Origin Energy Ltd  
ABN 30 000 051 696  
GPO Box 148  
Brisbane Qld. 4001  
Ph: (07) 3858 0600  
Fax: (07) 3369 7840

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DRAWN	BY	DATE	TITLE	REVISION
	CD		BEETALOO EXPLORATION DRILL CAMPAIGN VELKERRI 76 S2-1 DRILL PAD, ACCOMODATION CAMP AND WATER TANK GENERAL ARRANGEMENT PLAN	
			PROJECT NO.	DRAWING NO.
			MOD NO.	
			SCALE	CADFILE
			1:1000 @ A1	NT-2050-20-DA-0023.dwg
				A1



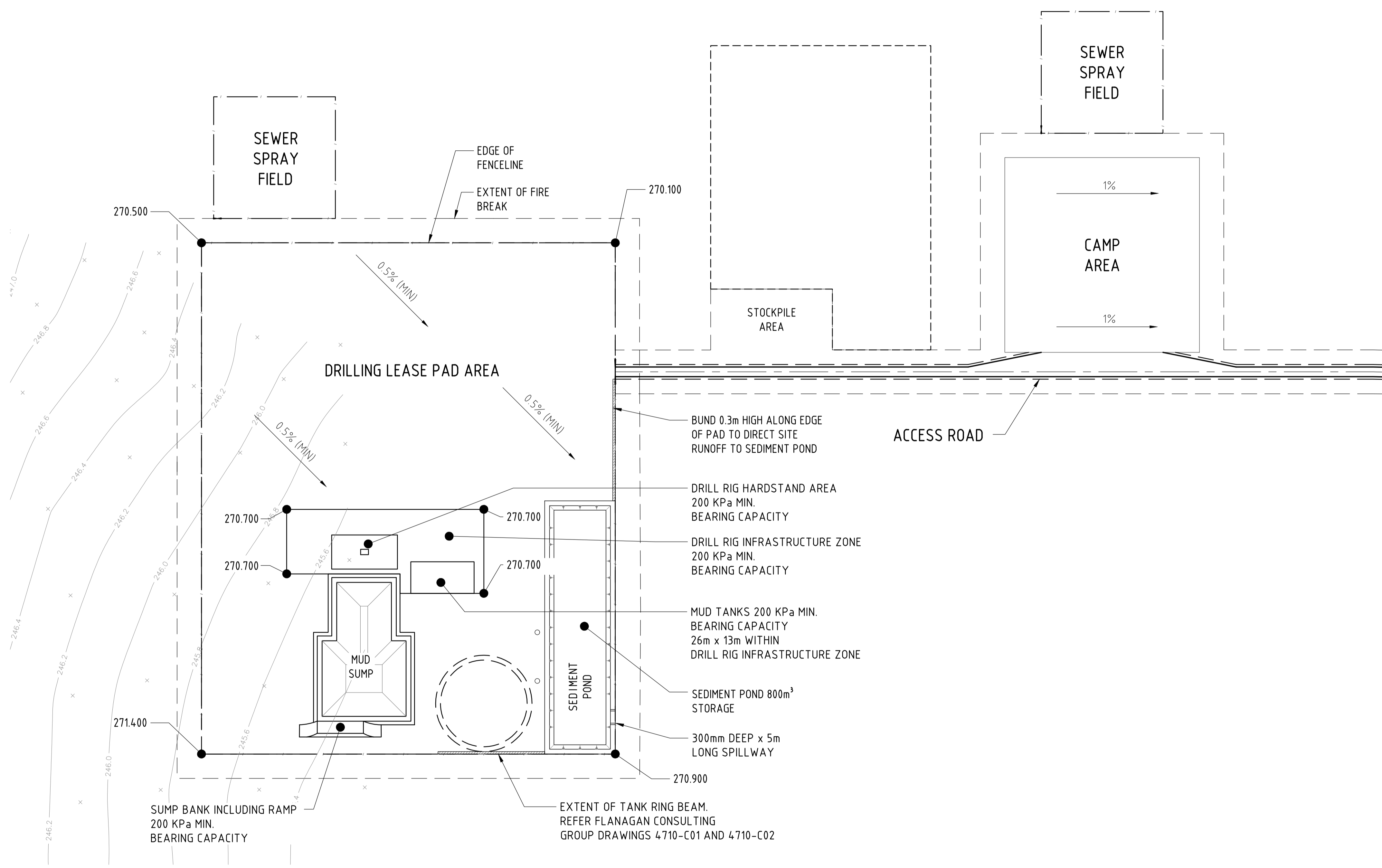
**LEGEND**

- EXISTING \_\_\_\_\_
- PROPOSED \_\_\_\_\_
- CONTOURS \_\_\_\_\_
- ACCESS ROAD CENTERLINE \_\_\_\_\_
- EDGE OF PAVEMENT \_\_\_\_\_
- EDGE OF SHOULDER \_\_\_\_\_
- EDGE OF FOOTPATH \_\_\_\_\_
- EXTENT OF CLEARING - (EXTENT OF FIRE BREAK) \_\_\_\_\_
- EDGE OF FENCELINE \_\_\_\_\_

**NOTES:**

1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
2. LEASE AND CAMP PAD TO BE COMPACTED TO 120KPA BEARING CAPACITY UNLESS OTHERWISE NOTED.
3. LEASE HARDSTAND TO BE COMPACTED TO 200 KPA BEARING CAPACITY.
4. BULK EARTHWORKS ARE TO BE MINIMISED WHERE POSSIBLE.
5. ROAD AND PAD PAVEMENTS ARE TO BE CONSTRUCTED TO FOLLOW EXISTING SURFACE LEVELS AS NEAR AS POSSIBLE AND TO THE GRADES SPECIFIED ON THE DRAWINGS.
6. CONTRACTOR IS RESPONSIBLE TO FIND/LOCATE EXISTING SERVICES. ANY DAMAGE TO EXISTING SERVICES TO BE RE-INSTATED AT THE CONTRACTORS EXPENSE.
7. ALL WORKS TO BE CARRIED OUT IN ACCORDANCE WITH THE APPROVED MANAGEMENT PLAN REQUIREMENTS.
8. NO CONSTRUCTION WORKS ARE TO BE CARRIED OUT OUTSIDE THE APPROVED WORK CORRIDOR BOUNDARIES.
9. CONSTRUCTION FACILITY AREA LOCATIONS TO BE APPROVED BY THE SUPERINTENDENT PRIOR TO WORKS COMMENCING.
10. TABLE DRAINS ARE TO BE CUT ALONG THE LENGTH OF THE ROAD AND ALL ROAD PAVEMENTS ARE TO HAVE A 4% CROSSFALL IN ACCORDANCE WITH THE ROAD CROSS-SECTION DETAILED ON DWG. NT-2050-20-DD-0023.
11. REFER TO DWG NT-2050-20-DD-0023 FOR ROAD PAVEMENT DETAILS. LAYDOWN AND VEHICLE AREA, LEASE PAD AND ACCOMMODATION PAD ARE TO BE STRIPPED OF 150mm AND THEN RIPPED AND RE-COMPACTED TO 95%MMDD. DRILL PAD IS TO BE TESTED FOR REQUIRED BEARING CAPACITIES AND THE ORIGIN SITE SUPERVISOR NOTIFIED IF THIS CAN NOT BE ACHIEVED.
12. REFER TO DRAWING NT-2050-20-DD-0031 FOR MUD SUMP DETAILS AND DRAWING NT-2050-20-DD-0027 FOR STEEL DRILLING CELLAR DETAILS.
13. FOR TANK RING BEAM DETAIL REFER FLANAGAN CONSULTING GROUP DRAWINGS 4710-C01 AND 4710-C02.
14. FINAL DRILLING LEASE PAD AREA GRADE TO BE CONFIRMED ON SITE BY ORIGIN SITE SUPERVISOR.

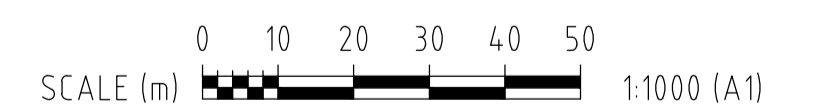
FOR CONTINUATION REFER TO DRG NT-2050-20-DD-0024



**GENERAL ARRANGEMENT PLAN**

**PRELIMINARY**

**NOT FOR CONSTRUCTION**



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DRAWING NO.	REFERENCE DRAWING TITLE	REV	DATE	REVISION DESCRIPTION	DRAWN	DWG CHECK	DESIGN	ENG DES CHECK	DE DRAFT DE PROJECT CHECK	SUPER APPROVAL	PROJECT APPROVALS	OTHERS
NT-2050-20-DD-0027	DRILLING CELLAR DETAILS											
NT-2050-20-DD-0023	DESIGN DETAILS											
		A	21.03.2019	PRELIMINARY ISSUE								

PREPARED FOR ORIGIN BY:

**AECOM**

AECOM Australia Pty Ltd  
A.B.N 20 093 846 925  
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Fax: (07) 3369 7840

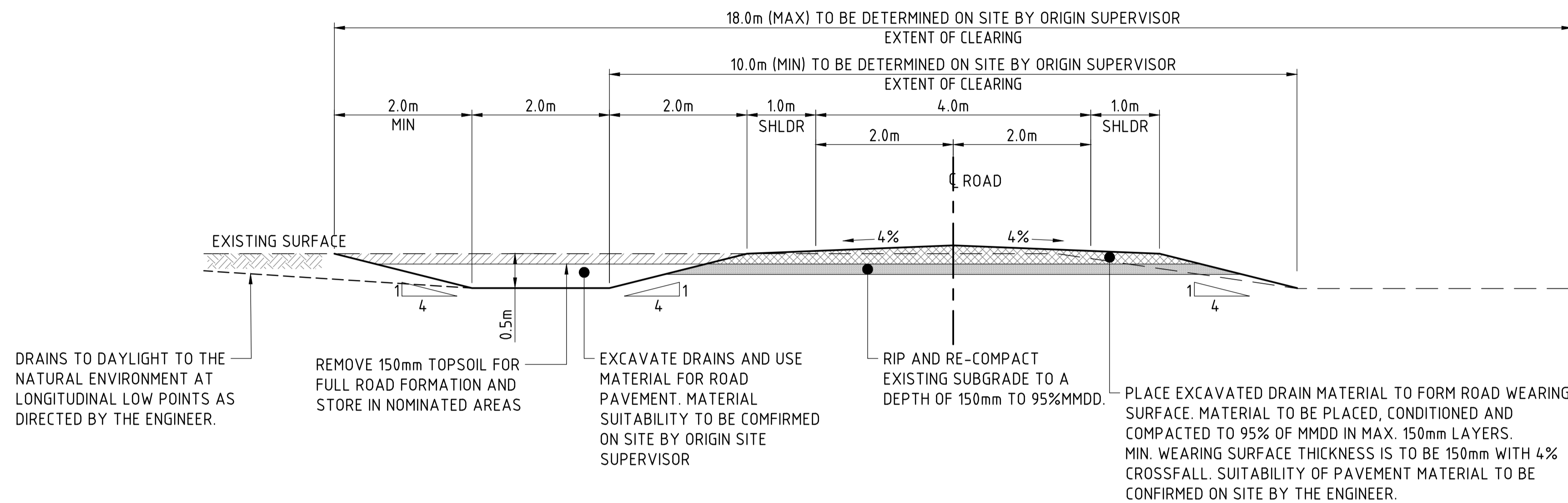
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DRAWN	BY	DATE	TITLE
CD	CD		BEETALOO EXPLORATION DRILL CAMPAIGN
			VELKERRI 76 S2-1
			DRILL PAD, ACCOMMODATION CAMP AND WATER TANK EARTHWORKS
			GENERAL ARRANGEMENT PLAN

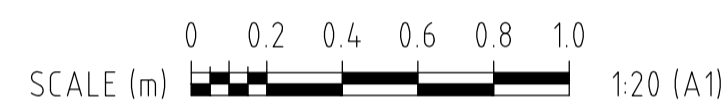
PROJECT NO.	DRAWING NO.	REVISION

SCALE 1:1000 @ A1

CADFILE NT-2050-20-DA-0026.dwg



TYPICAL CROSS SECTION - ACCESS ROAD



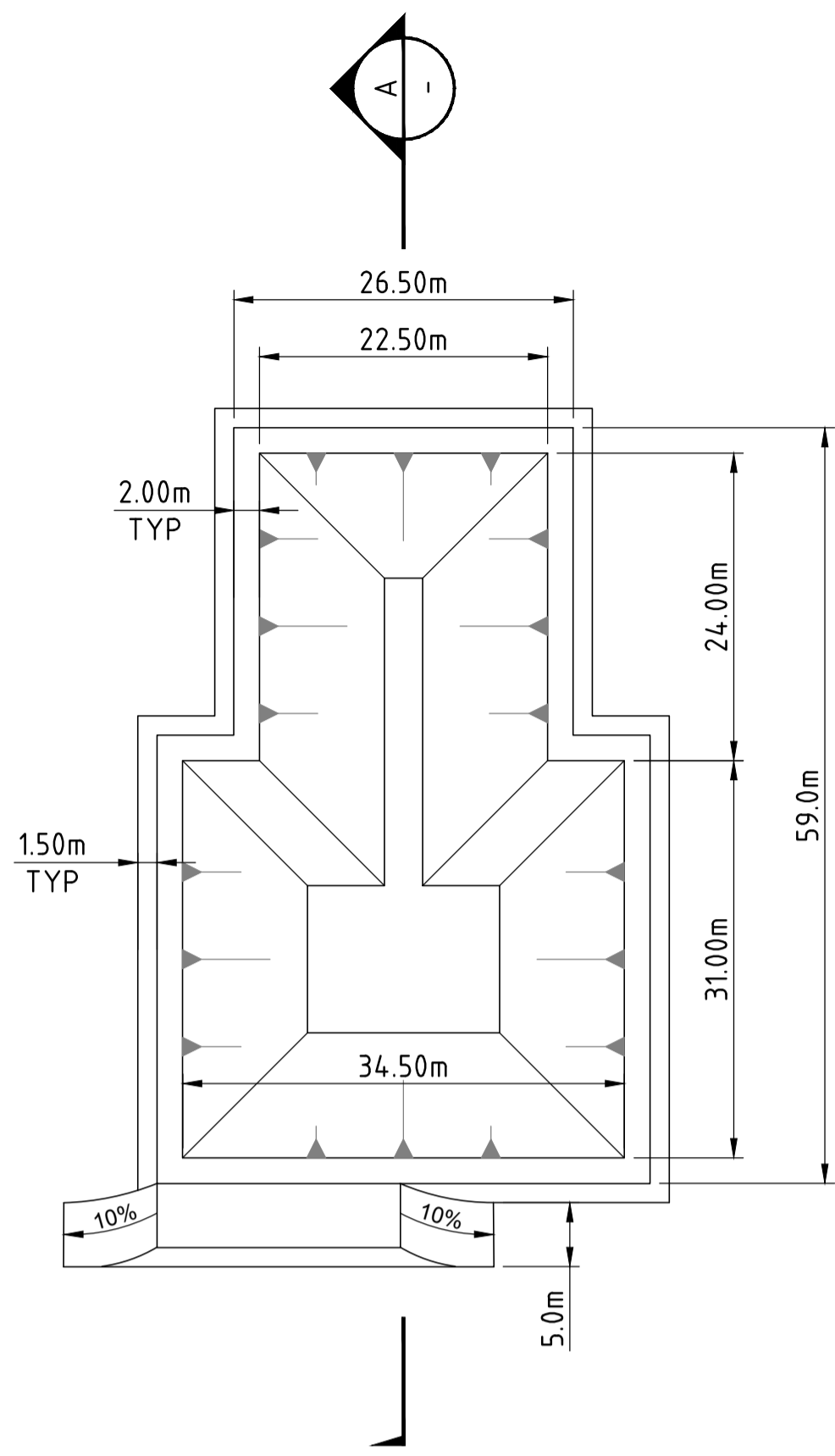
NOTES:

1. ALL UNITS ARE IN MILLIMETRES (mm) UNLESS NOTED OTHERWISE.
2. ENSURE THAT TABLE DRAINS ARE FREE DRAINING.
3. GROUND CONDITIONS AND SUITABLE MATERIALS TO BE CONFIRMED ON SITE BY SUPERINTENDENT.
4. CLEARED VEGETATION TO BE STORED ALONGSIDE NEW ROAD FOR FUTURE REHABILITATION.
5. REFER TO SPECIFICATION FOR COMPACTION REQUIREMENTS.
6. STRIPPED TOPSOIL TO BE STORED IN BERMS ALONGSIDE ROAD.
7. REFER TO SPECIFICATION FOR GENERAL REQUIREMENTS.
8. THE CONTRACTOR IS TO NOTIFY THE ORIGIN SUPERVISOR IF AREAS OF SOFT GROUND ARE ENCOUNTERED OR IF THE SPECIFICATION CANNOT BE ACHIEVED.
9. CLEAR, STRIP 150mm TOPSOIL AND STOCKPILE IN NOMINATED BUFFER ZONE TO ESTABLISH BORROW PITS.
10. THIS DRAWING MAY BE USED FOR TEMPORARY ACCESS APPLICATION TO NT ROADS.
11. TYPICAL CROSS SECTION DESIGNED IN ACCORDANCE WITH NORTHERN TERRITORY STANDARD DRAWING C(S)3003.

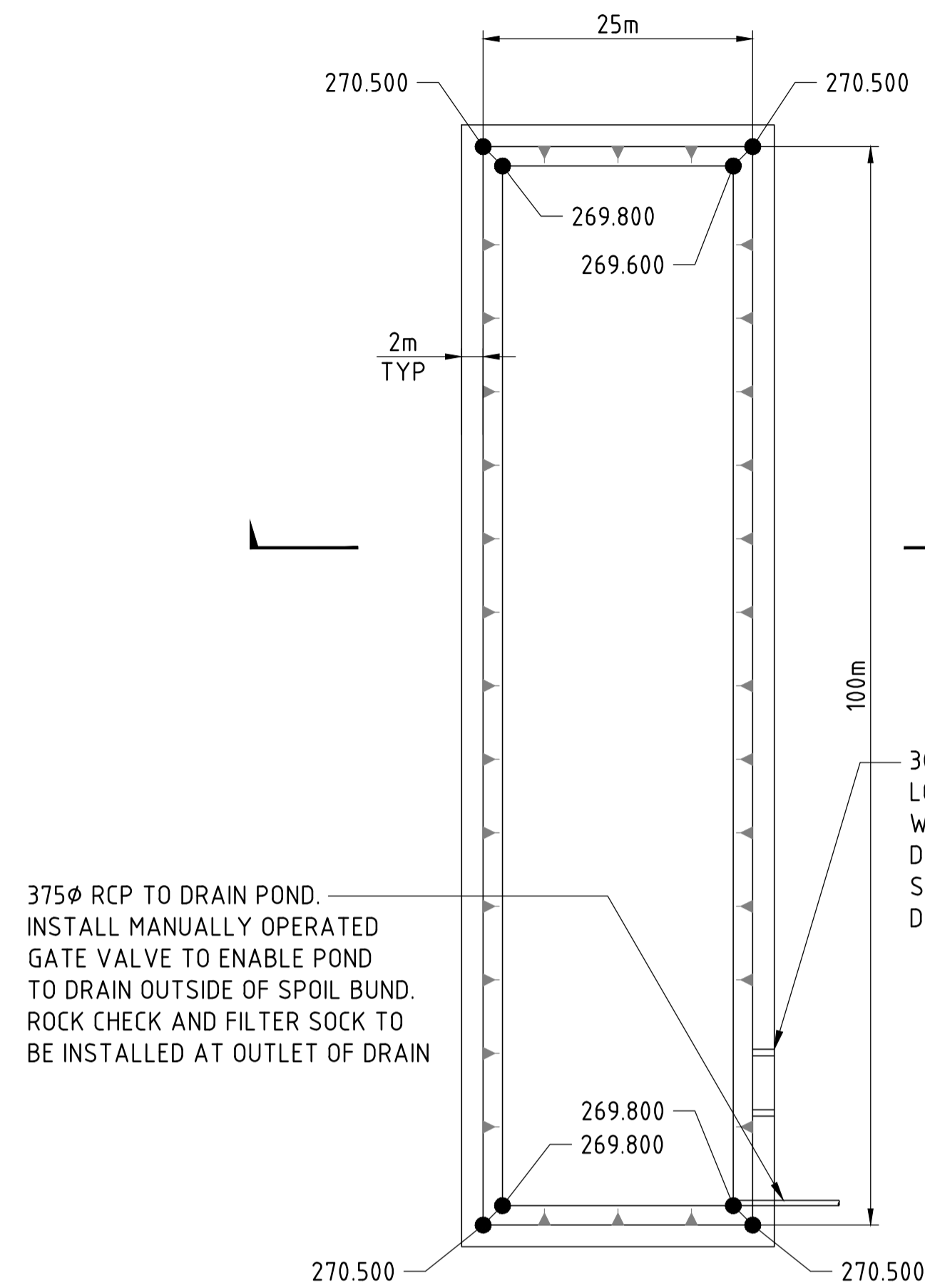
ISSUED FOR CONSTRUCTION

Thu, 18 Apr 2019 - 15:00pm P:\604\X\60480548\5 CAD\20-SHEETS\VELKERRI\76 S2-1\NT-2050-20-DD-0023.DWG Dudley, Calvin

DRAWING NO.		REFERENCE DRAWING TITLE		REV	DATE	REVISION DESCRIPTION	DRAWN	DWG CHECK	DESIGN	ENG DES CHECK	DE DRAFT DE PROJECT SUPER APPROVALS	PREPARED FOR ORIGIN BY <b>AECOM</b> AECOM Australia Pty Ltd A.B.N 20 093 846 925 www.aecom.com		Origin Energy Ltd ABN 30 000 051 696 GPO Box 148 Brisbane Qld. 4001 Ph: (07) 3858 0600 Fax: (07) 3369 7840	<table border="1"> <tr> <th>DRAWN</th> <th>BY</th> <th>DATE</th> <th>TITLE</th> </tr> <tr> <td>CRD</td> <td>CRD</td> <td>20.03.2019</td> <td>BEETALOO EXPLORATION DRILL CAMPAIGN</td> </tr> <tr> <td>PCM</td> <td>PCM</td> <td>20.03.2019</td> <td>VELKERRI 76 S2-1</td> </tr> <tr> <td>PCM</td> <td>PCM</td> <td>20.03.2019</td> <td>DESIGN DETAILS</td> </tr> </table>	DRAWN	BY	DATE	TITLE	CRD	CRD	20.03.2019	BEETALOO EXPLORATION DRILL CAMPAIGN	PCM	PCM	20.03.2019	VELKERRI 76 S2-1	PCM	PCM	20.03.2019	DESIGN DETAILS	<table border="1"> <tr> <th>PROJECT NO.</th> <th>DRAWING NO.</th> <th>REVISION</th> </tr> <tr> <td></td> <td>NT-2050-20-DD-0023</td> <td>0</td> </tr> </table>	PROJECT NO.	DRAWING NO.	REVISION		NT-2050-20-DD-0023	0	<table border="1"> <tr> <th>SCALE</th> <th>CADFILE</th> </tr> <tr> <td>1:1000 @ A1</td> <td>NT-2050-20-DD-0023.dwg</td> </tr> </table>	SCALE	CADFILE	1:1000 @ A1	NT-2050-20-DD-0023.dwg
DRAWN	BY	DATE	TITLE																																								
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**PLAN - MUD SUMP**  
Scale N.T.S.

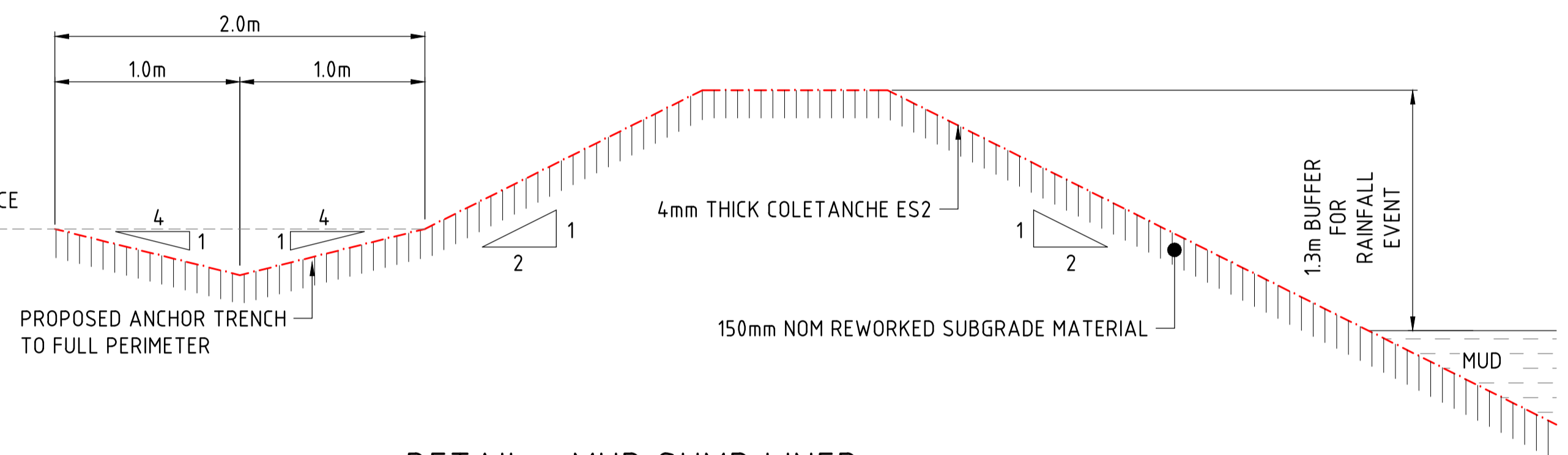


**PLAN - SECONDARY CONTAINMENT**  
Scale N.T.S.

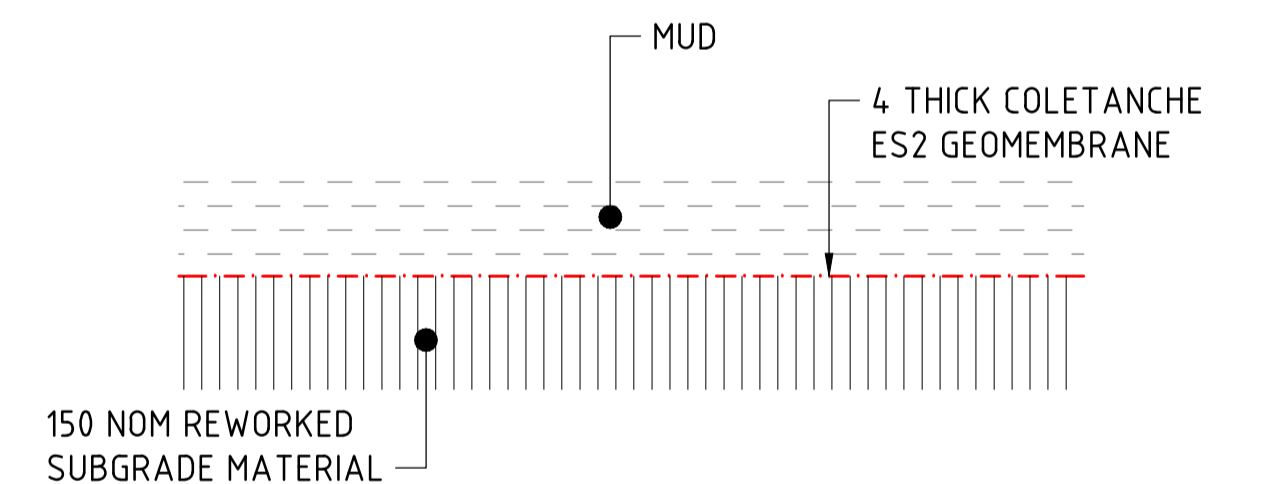
375φ RCP TO DRAIN POND.  
INSTALL MANUALLY OPERATED  
GATE VALVE TO ENABLE POND  
TO DRAIN OUTSIDE OF SPOIL BUND.  
ROCK CHECK AND FILTER SOCK TO  
BE INSTALLED AT OUTLET OF DRAIN

300mm DEEP x 5m  
LONG SPILLWAY LINE  
WITH GEOFABRIC. NOM.  
DIA. 200mm ROCK ON  
SPILLWAY FACE AND  
DOWN TO NATURAL SURFACE

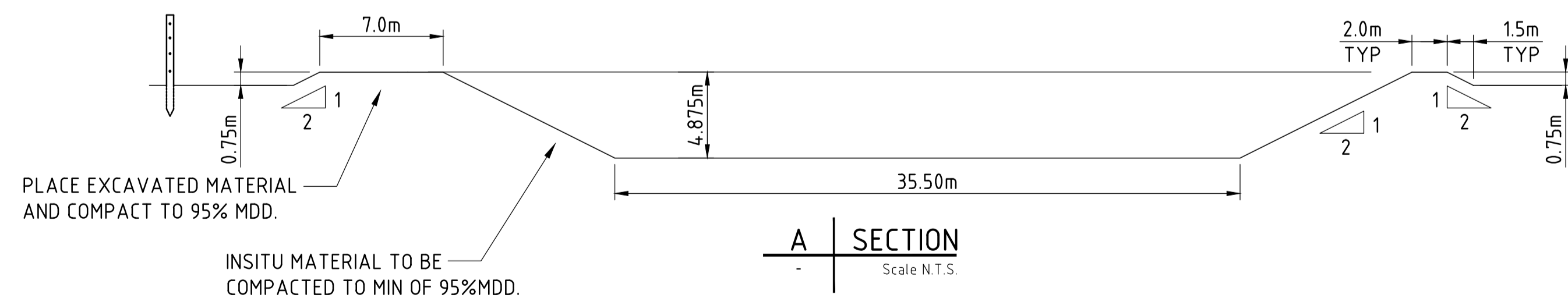
**NOTES:**  
1. GEOSYNTHETICS ARE DRAWN  
EXAGGERATED FOR CLARITY.



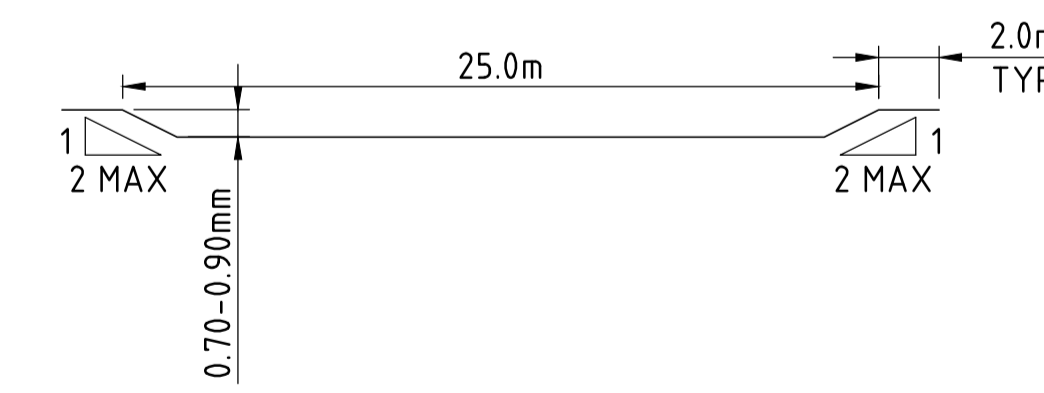
**DETAIL - MUD SUMP LINER**  
Scale N.T.S.



**DETAIL - BASE LINER**  
Scale N.T.S.



**A SECTION**  
Scale N.T.S.



**B SECTION**  
Scale N.T.S.

PLACE EXCAVATED MATERIAL  
AND COMPACT TO 95% MDD.  
INSITU MATERIAL TO BE  
COMPACTED TO MIN OF 95% MDD.

**ISSUED FOR CONSTRUCTION**

- NOTES:**
1. ALL UNITS ARE IN MILLIMETRES (mm) UNLESS NOTED OTHERWISE.
  2. GROUND CONDITIONS AND SUITABLE MATERIALS TO BE CONFIRMED ON SITE BY SUPERINTENDENT.
  3. REFER TO SPECIFICATION FOR COMPACTION REQUIREMENTS.
  4. REFER TO SPECIFICATION FOR GENERAL REQUIREMENTS.
  5. THE CONTRACTOR IS TO NOTIFY THE ORIGIN SUPERVISOR IF AREAS OF SOFT GROUND ARE ENCOUNTERED OR IF THE SPECIFICATION CANNOT BE ACHIEVED.
  6. REFER TO DRAWING NT-2050-20-DA-0023 FOR SETOUT DETAILS OF MUD SUMP.
  7. FAUNA LADDERS TO BE INSTALLED TO MUD SUMP.
  8. CONTRACTOR TO PROVIDE CATTLE PANELS FOR FENCING AROUND SUMP WHERE DEPTH IS GREATER THAN 1.5m.
  9. FENCE OR BARRICADE TO BE INSTALLED AT SUMP LOAD OUT LOCATION TO ENSURE VEHICLES DO NOT COMPROMISE SUMP WALL/ENTER SUMP.
  10. MUD SUMP VEHICLE OFFLOAD AREA TO BE COMPACTED TO 200 kPa

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NT-2050-20-DA-0022		GENERAL ARRANGEMENT PLAN		1	16.04.19	ISSUED FOR CONSTRUCTION	CRD	PCM	PCM	JMJ				60480548	DARWIN	CRD	20.03.2019	BEETALOO EXPLORATION DRILL CAMPAIGN VELKERRI 76 S2-1 MUD SUMP DETAILS	1
															DRAWING NO.	NT-2050-20-DD-0031	1		
															SCALE	1:1000 @ A1	CADFILE	NT-2050-20-DD-0031.dwg	A1

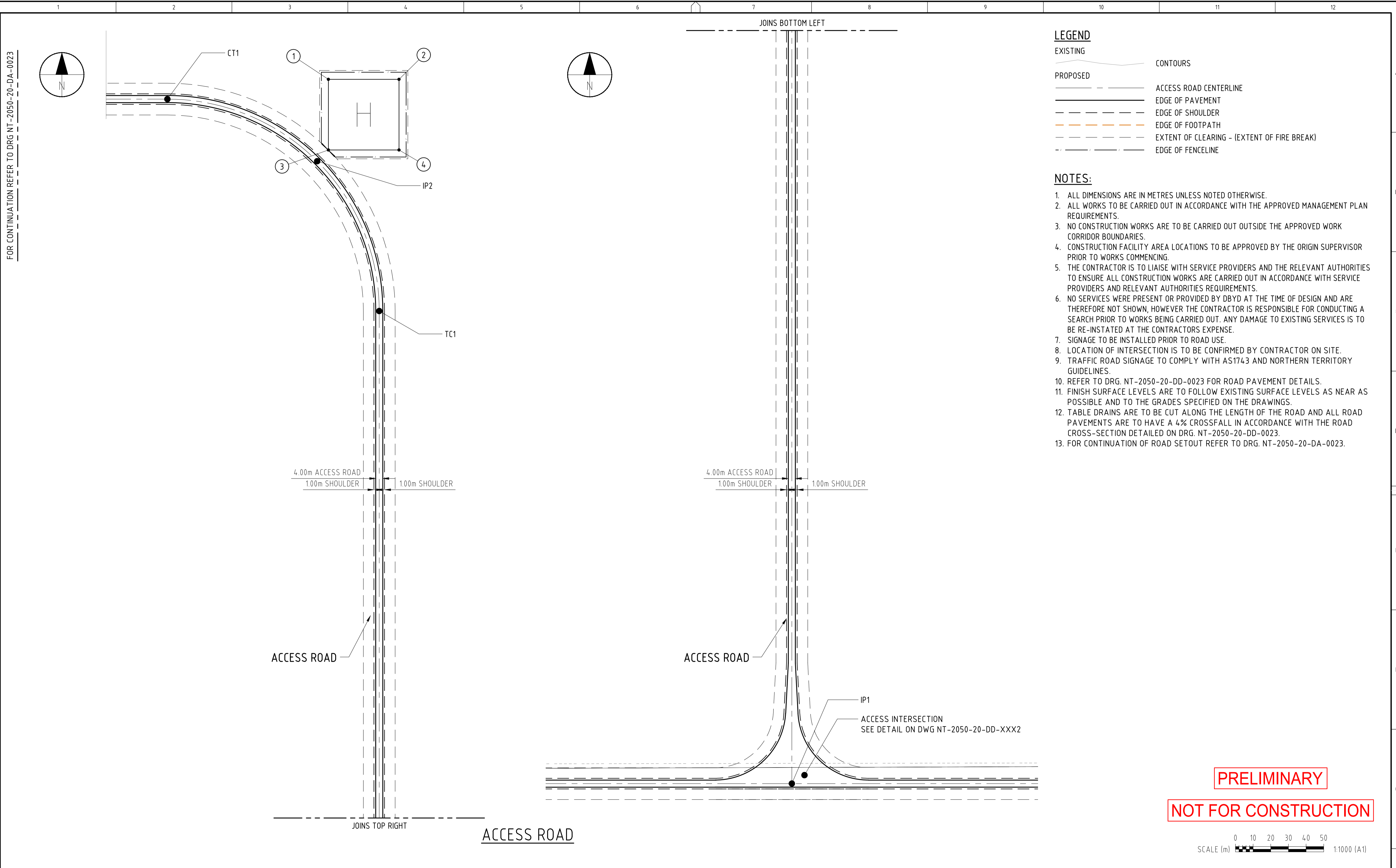


Origin Energy Ltd  
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GPO Box 148  
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Fax: (07) 3369 7840

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DRAWN	CRD	20.03.2019
DWG CHECK	PCM	20.03.2019
DESIGN	PCM	20.03.2019
ENG DES CHECK	JMJ	20.03.2019
DRAFT		
SUPER		
PROJECT		
APPROVAL		





- LEGEND**
- EXISTING
    - CONTOURS
  - PROPOSED
    - ACCESS ROAD CENTERLINE
    - EDGE OF PAVEMENT
    - - - EDGE OF SHOULDER
    - - - - - EDGE OF FOOTPATH
    - - - - - EXTENT OF CLEARING - (EXTENT OF FIRE BREAK)
    - - - - - EDGE OF FENCELINE

- NOTES:**
1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
  2. ALL WORKS TO BE CARRIED OUT IN ACCORDANCE WITH THE APPROVED MANAGEMENT PLAN REQUIREMENTS.
  3. NO CONSTRUCTION WORKS ARE TO BE CARRIED OUT OUTSIDE THE APPROVED WORK CORRIDOR BOUNDARIES.
  4. CONSTRUCTION FACILITY AREA LOCATIONS TO BE APPROVED BY THE ORIGIN SUPERVISOR PRIOR TO WORKS COMMENCING.
  5. THE CONTRACTOR IS TO LIAISE WITH SERVICE PROVIDERS AND THE RELEVANT AUTHORITIES TO ENSURE ALL CONSTRUCTION WORKS ARE CARRIED OUT IN ACCORDANCE WITH SERVICE PROVIDERS AND RELEVANT AUTHORITIES REQUIREMENTS.
  6. NO SERVICES WERE PRESENT OR PROVIDED BY DBYD AT THE TIME OF DESIGN AND ARE THEREFORE NOT SHOWN, HOWEVER THE CONTRACTOR IS RESPONSIBLE FOR CONDUCTING A SEARCH PRIOR TO WORKS BEING CARRIED OUT. ANY DAMAGE TO EXISTING SERVICES IS TO BE RE-INSTATED AT THE CONTRACTORS EXPENSE.
  7. SIGNAGE TO BE INSTALLED PRIOR TO ROAD USE.
  8. LOCATION OF INTERSECTION IS TO BE CONFIRMED BY CONTRACTOR ON SITE.
  9. TRAFFIC ROAD SIGNAGE TO COMPLY WITH AS1743 AND NORTHERN TERRITORY GUIDELINES.
  10. REFER TO DRG. NT-2050-20-DD-0023 FOR ROAD PAVEMENT DETAILS.
  11. FINISH SURFACE LEVELS ARE TO FOLLOW EXISTING SURFACE LEVELS AS NEAR AS POSSIBLE AND TO THE GRADES SPECIFIED ON THE DRAWINGS.
  12. TABLE DRAINS ARE TO BE CUT ALONG THE LENGTH OF THE ROAD AND ALL ROAD PAVEMENTS ARE TO HAVE A 4% CROSSFALL IN ACCORDANCE WITH THE ROAD CROSS-SECTION DETAILED ON DRG. NT-2050-20-DD-0023.
  13. FOR CONTINUATION OF ROAD SETOUT REFER TO DRG. NT-2050-20-DA-0023.

**PRELIMINARY**

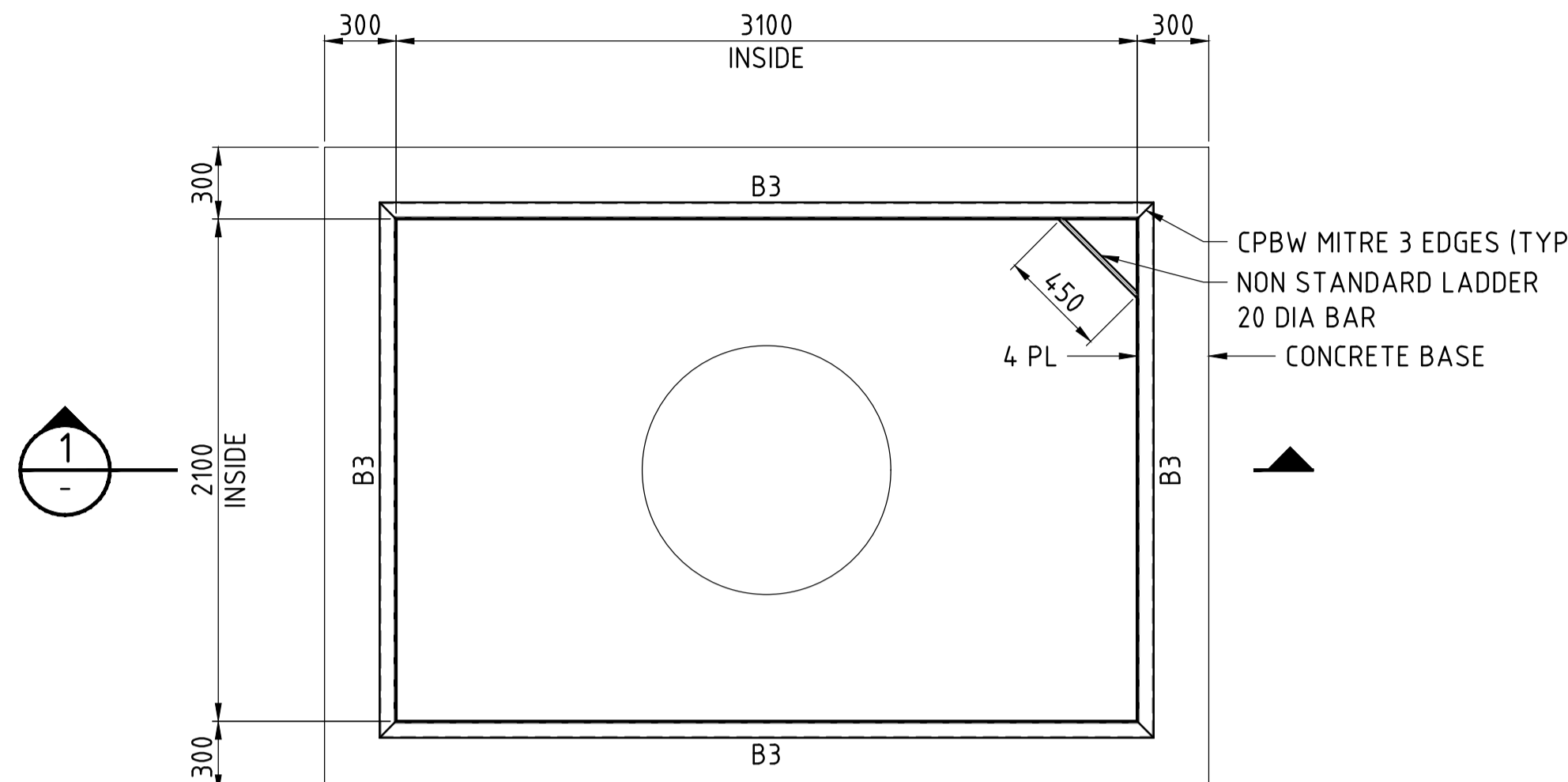
**NOT FOR CONSTRUCTION**

SCALE (m) 1:1000 (A1)

NT-2050-20-DA-XXX2 PAD INTERSECTION DETAIL NT-2050-20-DA-0023 GENERAL ARRANGEMENT PLAN		A 21.03.2019 PRELIMINARY ISSUE	CD - - - - - DWG CHECK - - - - - DESIGN - - - - - ENG DES CHECK - - - - - DE DRAFT DE PROJET SUPER APPROVALS - - - - -	PROJECT: 60480548 BEETALOO EXPLORATION DRAWING OFFICE: DARWIN	Origin Energy Ltd ABN 30 000 051 696 GPO Box 148 Brisbane Qld. 4001 Ph: (07) 3858 0600 Fax: (07) 3369 7840	DRAWN: CD DWG CHECK: - DESIGN: - ENG DES CHECK: - DRAFT: - SUPER: - PROJECT APPROVAL: -	BY: CD DATE: - - - - - TITLE: BEETALOO EXPLORATION DRILL CAMPAIGN VELKERRI 76 S2-1 DRILL PAD, ACCOMMODATION CAMP AND WATER TANK ACCESS ROAD	PROJECT NO: MOD NO: SCALE: 1:1000 @ A1	DRAWING NO: <b>NT-2050-20-DD-0025</b> CADFILE: NT-2050-20-DD-0025.dwg	REVISION: <b>A</b> A1
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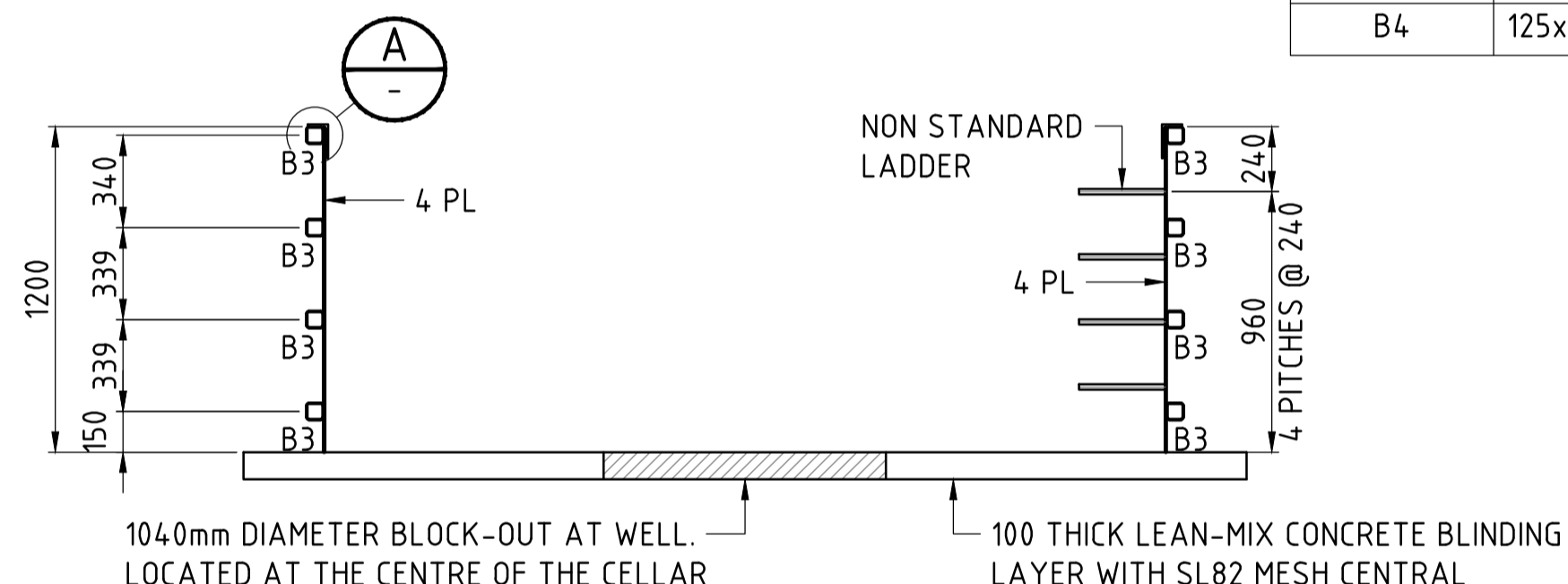
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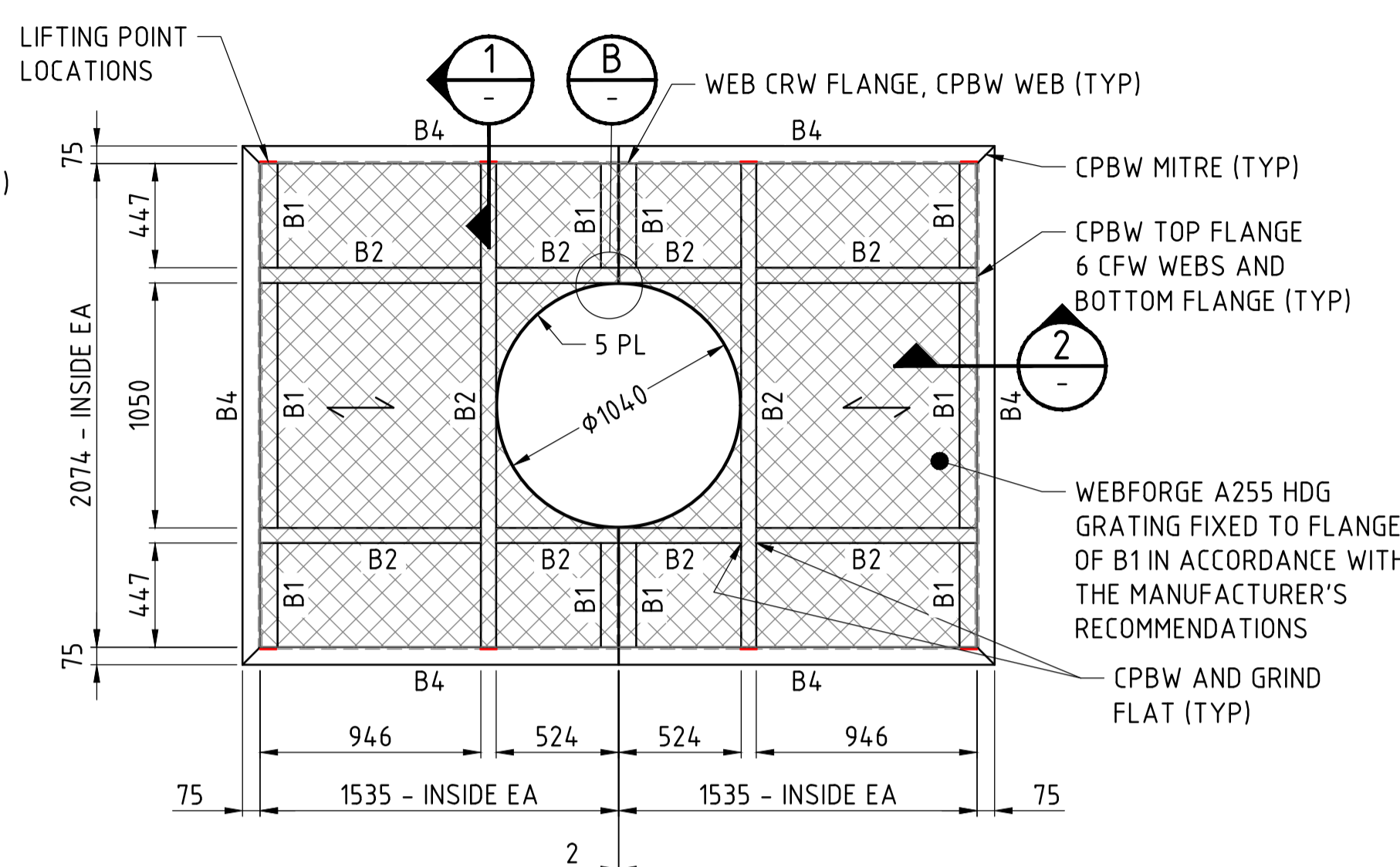


CELLAR PLAN  
SCALE 1:25

MARK	SIZE
B1	75x8 EA
B2	65x4 SHS
B3	65x4 SHS
B4	125x75x8 UA

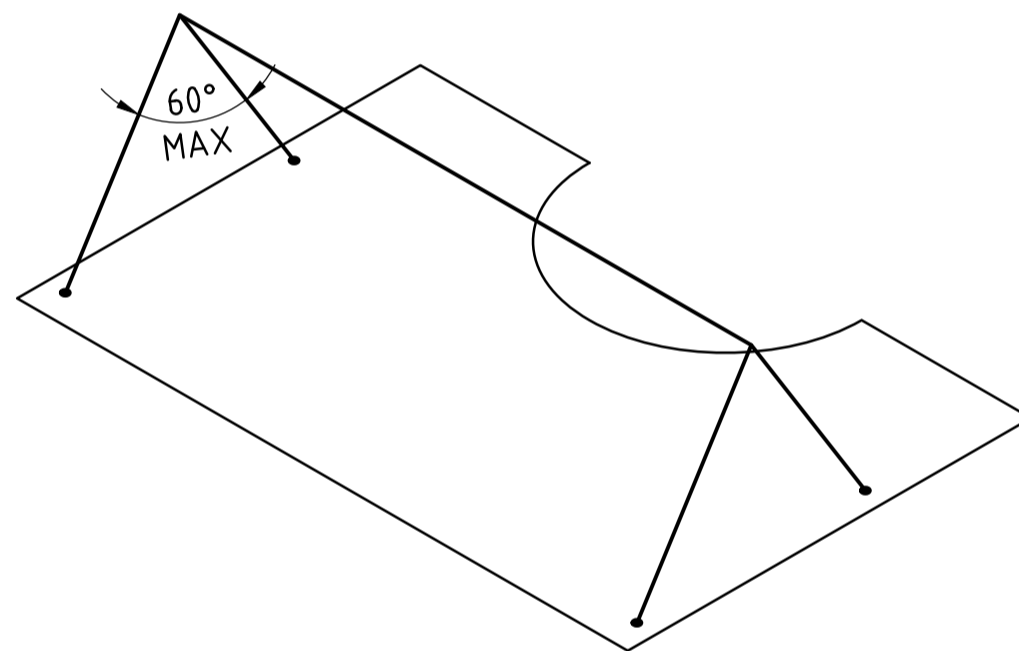


SECTION 1  
SCALE 1:25



CELLAR COVER PLAN  
SCALE 1:25

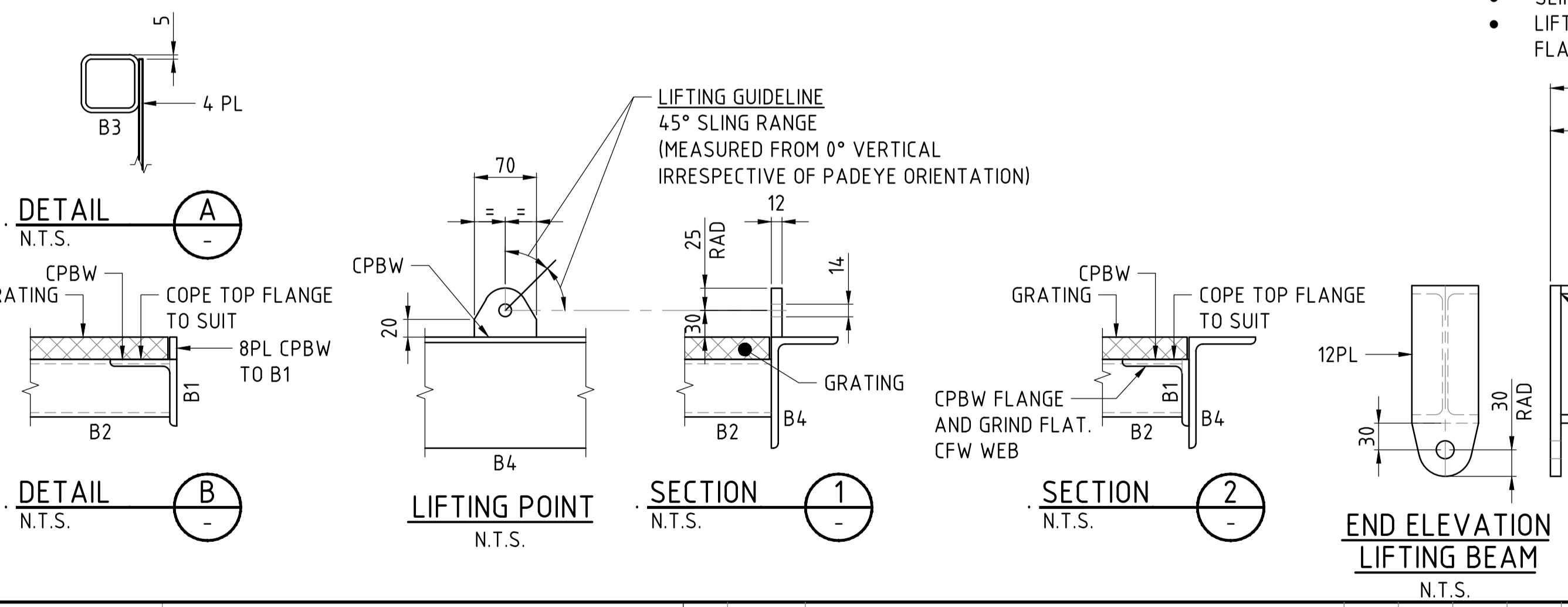
← GRATING SPAN DIRECTION



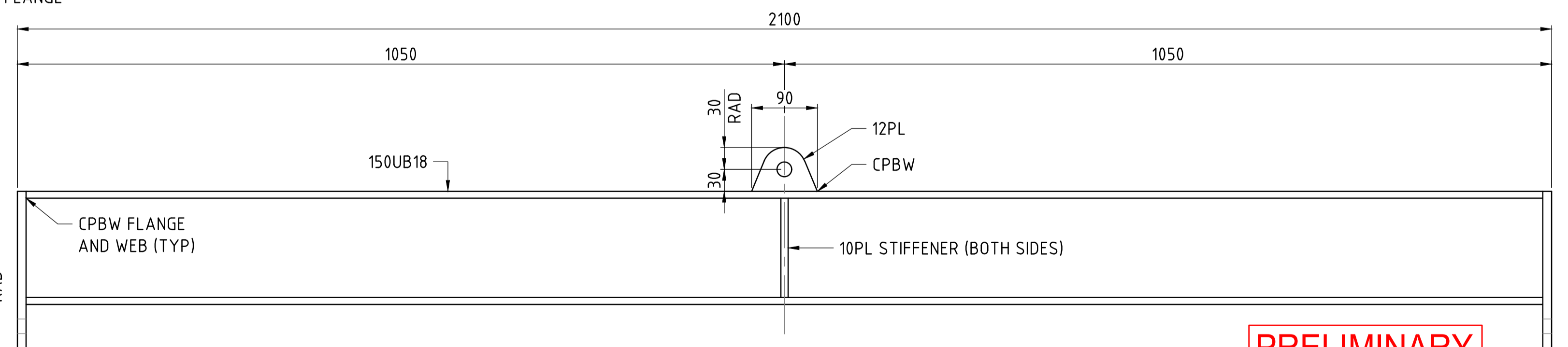
LIFTING DIAGRAM

LIFTING NOTES

- DESIGN ASSUMES A DYNAMIC IMPACT FACTOR  $K_d=1.2$  AND FACTOR OF SAFETY (FOS) OF 3.0
- SLING ANGLE MUST BE 60 DEGREES MAXIMUM AT THE HOOK.
- LIFTING BEAM SHALL HAVE WWL200kg STAMPED INTO FLANGE



END ELEVATION LIFTING BEAM  
N.T.S.



LIFTING BEAM  
N.T.S.

GENERAL NOTES

- THE FOOTINGS HAVE BEEN DESIGNED FOR A SAFE BEARING PRESSURE OF 50 kPa.
- THE FOOTING DEPTH SHALL BE CHECKED BY THE SUPERINTENDENT AFTER EXCAVATION, AND THE DEPTH MAY BE VARIED FROM THAT DETAILED ON THE DRAWINGS DEPENDING ON THE EXACT LOCATION OF THE LOAD BEARING STRATA.
- FILL UNDER BUILDING FLOOR SLABS: GRANULAR MATERIAL COMPACTED TO A DRY DENSITY RATIO NOT LESS THAN 98% (STANDARD COMPACTION).
- FILL UNDER PAVEMENT SLABS: GRANULAR MATERIAL TO A MIN. THICKNESS OF 50mm UNO ALL FILL AND TOP 150mm OF SUBGRADE COMPACTED TO A DRY DENSITY RATIO NOT LESS THAN 98% (STANDARD COMPACTION).
- DESIGN LIVE LOADS HAVE BEEN CALCULATED IN ACCORDANCE WITH A.S. 1170 PART 1 & A.S. 1657.
- DESIGN LIVE LOAD SURCHARGE ON SOIL 5 kPa
- THESE DRAWINGS SHALL BE READ IN CONJUNCTION WITH THE ARCHITECTS AND OTHER ENGINEERS DRAWINGS, AND ALL DIMENSIONS AND DETAILS SHALL BE CHECKED WITH THEIR DRAWINGS AND ON SITE.
- TRADE NAMES HAVE BEEN USED ONLY TO ESTABLISH A BASIC REQUIREMENT AND ANY SATISFACTORY EQUIVALENT MAY BE SUBMITTED FOR REVIEW.
- ALL DIMENSIONS OF EXISTING STRUCTURES SHALL BE CHECKED PRIOR TO FABRICATION AND ERECTION.
- DURING CONSTRUCTION THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING THE STRUCTURE AND EXCAVATIONS IN A STABLE CONDITION, AND ENSURING NO PART SHALL BE OVERSTRESSED UNDER CONSTRUCTION ACTIVITY.

CONCRETE NOTES

- CONCRETE, CONCRETE WORK, AND STEEL REINFORCEMENT SHALL CONFORM TO A.S. 3600, CONCRETE STRUCTURES.
- THE PROPORTION OF FLY ASH SHALL BE 25% BY WEIGHT OF THE TOTAL COMBINED WEIGHT OF FLY ASH AND CEMENT.
- MAXIMUM SLUMP OF CONCRETE = 80±15mm UNO.
- MAXIMUM NOMINAL SIZE OF AGGREGATE = 20mm.
- PLACE 2.N12 REINFORCING BARS X 1000 LONG IN TOP REINF. LAYER DIAGONALLY ACROSS ALL RE-ENTRANT CORNERS AND OPENINGS.
- REINFORCEMENT SHOWN ON DRAWINGS IS REPRESENTED DIAGRAMMATICALLY AND NOT NECESSARILY IN TRUE PROJECTION.
- ALL REINFORCEMENT HOOKS AND COGS SHALL BE STANDARD UNLESS SHOWN OR NOTED OTHERWISE ON THE DRAWINGS.
- ALL REINFORCING STEEL SHALL BE ACRS (AUSTRALIAN CERTIFICATION AUTHORITY FOR REINFORCING AND STRUCTURAL STEEL) CERTIFIED.

STEELWORK NOTES

- ALL STEELWORK SHALL CONFORM TO A.S. 4100, STEEL STRUCTURES.
- STEEL GRADES: 300 UNO. SHS - 350. PLATES - 250.
- FABRICATION SHALL BE CARRIED OUT BY WELDERS WHO ARE QUALIFIED IN ACCORDANCE WITH THE REQUIREMENTS OF A.S./NZS 1554.1.
- THE BOLTING PROCEDURE ADOPTED UNLESS NOTED OTHERWISE IS 8.8/S IN ACCORDANCE WITH THE AUSTRALIAN INSTITUTE OF STEEL CONSTRUCTION - MANUAL OF STANDARDISED STRUCTURAL CONNECTIONS.
- ALL BOLTS OR FASTENERS SHALL BE MARKED WITH THE MANUFACTURERS BRAND, AND COMPLY WITH THE FOLLOWING:
  - BOLTS DENOTED 4.6/S ARE COMMERCIAL BOLTS OF STRENGTH GRADE 4.6 TO A.S. 1111 - SNUG TIGHT.
  - BOLTS DENOTED 8.8/S, 8.8/TF, OR 8.8/TB ARE HIGH STRENGTH STRUCTURAL BOLTS OF STRENGTH GRADE 8.8 TO A.S. 1252.
- BOLTS SHALL BE M20 8.8/S UNO.
- GRADE 8.8 BOLTS SHALL NOT BE WELDED, INCLUDING TACK WELDS FOR CAGING.
- PLATES IN STRUCTURAL STEEL CONNECTIONS SHALL BE 10mm THICK UNO
- MINIMUM CONNECTIONS SHALL BE 10PL. 2/M20 8.8/S BOLTS UNO.
- ALL BOLTS (INCLUDING MASONRY ANCHORS) SHALL BE HOT DIPPED GALVANISED.
- ALL WELDS SHALL BE 6 CFW UNLESS NOTED OTHERWISE.
- ALL WELDS SHALL BE CATEGORY S.P. AS SPECIFIED IN A.S. 1554, UNO.
- ELECTRODES SHALL BE B-G49X OR B-T49X UNO.
- ALL RHS AND CHS MEMBERS SHALL HAVE 5 PL. SEAL PLATES AT ENDS UNO.
- PROTECTIVE COATING SHALL BE EITHER
  - ALL STEELWORK SHALL BE BLAST CLEANED TO CLASS 2½ AS SPECIFIED IN AS 1627.4 WITH SURFACE ROUGHNESS OF 75 MICRONS
  - 2 COATS OF IMMERSION GRADE EPOXY TO DRY FILM THICKNESS 400 MICRONS (EACH COAT).
- OR
  - HOT DIP GALVANISED TO AS4680
- SHOP DRAWINGS SHALL BE SUBMITTED BEFORE COMMENCEMENT OF FABRICATION. GRADE OF SANDBLASTING, PAINT BRAND, TYPE, FILM THICKNESS AND WELD CATEGORY SHALL BE NOTED ON THESE DRAWINGS.
- ALL MEMBER CENTROIDS AT CONNECTIONS SHALL INTERSECT AT A POINT UNO GAUGE LINES MAY BE USED IN LIEU OF CENTROIDS FOR BOLTED END CONNECTIONS OF ANGLES.
- ALL STRUCTURAL STEEL SHALL BE ACRS (AUSTRALASIAN CERTIFICATION AUTHORITY FOR REINFORCING AND STRUCTURAL STEEL) CERTIFIED.

PRELIMINARY

NOT FOR CONSTRUCTION

DRAWING NO.	REFERENCE DRAWING TITLE	REV	DATE	PRELIMINARY ISSUE	REVISION DESCRIPTION	DRAWN	DWG CHECK	DESIGN	ENG DES CHECK	DE DRAFT DE PROJECT CHECK	SUPER APPROVAL	APPROVALS	PROJECT APPROVALS - OTHERS	DRAWING OFFICE	DATE	TITLE	REVISION
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

PREPARED FOR ORIGIN BY:  
**AECOM**  
AECOM Australia Pty Ltd  
A.B.N 20 093 846 925  
www.aecom.com

**origin**

Origin Energy Ltd  
ABN 30 000 051 696  
GPO Box 148  
Brisbane Qld. 4001  
Ph: (07) 3858 0600  
Fax: (07) 3369 7840

DRAWN	BY	DATE	TITLE
-	-	-	BEETALOO EXPLORATION DRILL CAMPAIGN
-	-	-	VELKERRI 76 S2-1
-	-	-	DRILLING CELLAR DETAILS

PROJECT NO.	DRAWING NO.
-	-

NT-2050-20-DD-0027 A

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SCALE	CADFILE
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# PRODUCT DATA SHEET

## COLETANCHE ES 2



### DESCRIPTION

COLETANCHE ES 2 is an SBS elastomeric modified bituminous geomembrane.

### USE

Moderate level of mechanical resistance, for use an environmental protection and groundworks waterproofing, in particular :

- To cover landfill,
- Hydraulic ponds,
- Containment of Industrial liquid wastes,
- Canals ,
- Contaminated land.

Product use must be validated by Axter

### APPLICATION METHOD

By torch welding or other similar technique

### STORAGE

Rolls must not be stored directly on the ground. Provide suitable supports (blocks, slides, wooden planks) with a minimum height of 35 cm to be placed under the ends of the mandrel.

### COMPOSITION

(indicative)

Reinforcement (g/m <sup>2</sup> ) :	Glass mat	50
Reinforcement (g/m <sup>2</sup> ) :	Non-woven geotextile	250
Binder (g/m <sup>2</sup> ) :	Elastomeric SBS	4300
Surface finish (g/m <sup>2</sup> ) :	Sand	250
Under surface finish (g/m <sup>2</sup> ) :	Polyester antirroot film	15

### CHARACTERISTICS

		STANDARD	UNITS	AVERAGE	Minimum
Dimensions	Length	-	m	80	79
	Width		m	5.10	5.01
Thickness (on finished product)		ASTM D 5199	mm	4.00	3.60
Surface mass		ASTM D 3776	kg/m <sup>2</sup>	4.85	4.30
Resistance to tearing	Longitudinal	ASTM D 4073	N	825	619
	Cross direction			700	525
Tensile properties : maximum tensile strength	Longitudinal	ASTM D 7275	kN/m	27	20.3
	Cross direction			24	15
Tensile properties : elongation	Longitudinal		%	50	35
	Cross direction			50	35
Static Puncture		ASTM D 4833	N	530	477
Flexibility at low temperature	Longitudinal	ASTM D 5147	°C	-20	-15
	Cross direction			-20	-15
Water permeability (liquid tightness)		ASTM E 96	m/s	6.10 <sup>-14</sup>	<
Gas permeability (gas tightness)		ASTM D 1434-82	m <sup>3</sup> /(m <sup>2</sup> .j.atm)	2.10 <sup>-4</sup>	<

NOTE: AXTER COLETANCHE INC. may modify the composition and/or utilisation of its products without prior notice. Consequently orders will be filled according to the latest specification.



GENERAL

- 1. ALL WORK EXCLUDING WORK ASSOCIATED WITH LINER SUPPLY AND INSTALLATION SHALL BE COMPLETED IN ACCORDANCE WITH 'ORIGIN' TECHNICAL SPECIFICATION Q-4522-20-TS-0001...

ENVIRONMENTAL AND SEDIMENT CONTROL NOTES

- 1. THE CONTRACTOR SHALL AVOID DISTURBANCE OF ENVIRONMENTALLY SENSITIVE AREAS. UNLESS NOTED OTHERWISE IN THE CONTRACT DOCUMENTS, THE CONTRACTOR SHALL INSTALL TEMPORARY FENCING...

POND EARTHWORKS

- 1. EARTHWORKS SHALL GENERALLY BE COMPLETED IN ACCORDANCE WITH 'ORIGIN' TECHNICAL SPECIFICATION Q-4522-20-TS-0001...

TOPSOIL REINSTATEMENT AND AMENDMENT

- 1. TOPSOIL SHALL BE PLACED TO ALL DISTURBED AREAS EXCLUDING AREAS OCCUPIED BY PAVEMENTS, SPILLWAYS AND CAPPING MATERIAL OR AS DIRECTED BY THE SUPERINTENDENT...

BITUMINOUS GEOMEMBRANE LINER PRODUCT DATA

- 1. DESCRIPTION - BGM IS AN SBS ELASTOMERIC MODIFIED BITUMINOUS GEOMEMBRANE.

Table with 2 columns: Component and Value. Includes GLASS MAT, NON-WOVEN GEOTEXTILE, ELASTOMERIC SBS, SAND, POLYESTER ANTIROOT FILM.

CHARACTERISTICS

Table with columns: Property, Standard, Units, Values, Tolerance. Includes DIMENSIONS, THICKNESS, SURFACE MASS, RESISTANCE TO TEARING, TENSILE PROPERTIES, etc.

BITUMINOUS GEOMEMBRANE LINER INSTALLATION

- 1. BITUMINOUS GEOMEMBRANE INSTALLATION SHALL BE PERFORMED IN ACCORDANCE TO THE MANUFACTURER'S RECOMMENDATION.

RPEQ No. 15858
Name: B. R. C.

BGM INSTALLATION (CONTINUED)

- 7. THE PROCEDURES AND EQUIPMENT USED SHALL NOT ELONGATE, WRINKLE, SCRATCH, OR OTHERWISE DAMAGE THE BITUMINOUS GEOMEMBRANE.

BGM INSTALLATION (CONTINUED)

- 29. FOLLOWING INSTALLATION OF THE LINER, A DETAILED VISUAL INSPECTION OF THE PRIMARY LINER SURFACE SHALL BE PERFORMED BY THE PRINCIPAL.

BITUMINOUS GEOMEMBRANE LINER BALLAST ANCHORS

- 1. BALLAST ANCHORS SHALL BE SOIL ANCHOR PENETRATOR PE18SQ (OR ENGINEER APPROVED EQUIVALENT).

Project details and approvals section including logos for MWH, Australia Pacific LNG, and Origin Energy Ltd, along with drawing information and revision history.

**Appendix C Water Extraction Licence Statement of Reason.**

## Water Extraction Licence Decision

### Application

1. The following application (**Application**) for a licence to take water from a bore was lodged in accordance with section 60 of the *Water Act 1992 (Act)* by Origin Energy B2 Pty Ltd (**Applicant**):

<b>Applicant:</b>	Origin Energy B2 Pty Ltd (ABN 42 105431525)
<b>Date Licence applied for:</b>	15 March 2019
<b>Licence applied for:</b>	Licence to take water from a bore under section 60 of the <i>Water Act</i>
<b>Purpose for which Licence is sought:</b>	Petroleum activities
<b>Maximum quantity of water proposed to be taken annually for each beneficial use:</b>	
Petroleum Activities	175 ML p.a.
<b>Land from which water will be taken:</b>	NT Portion 1079 (8240 Carpentaria Hwy, Arnold),  NT Portion 7027 (4500 Carpentaria Hwy, Birdum).
<b>Land on which water will be used:</b>	NT Portion 702 (16965 Carpentaria Hwy, Pamayu),  NT Portion 1079 (8240 Carpentaria Hwy, Arnold),  NT Portion 7026 (14981 Stuart Hwy, Birdum),  NT Portion 7027 (4500 Carpentaria Hwy, Birdum).
<b>Bores from which water will be taken</b>	RN040895
<b>Water Source:</b>	Gum Ridge Formation
<b>Water Control District:</b>	Daly Roper Beetaloo Water Control District
<b>Declared Water Allocation Plan:</b>	No declared plan



## Decision

2. In accordance with sections 60 and 71C of the Act, I have decided to grant the following licence for the reasons given below (**Licence**):

<b>Applicant:</b>	Origin Energy B2 Pty Ltd (ABN 42 105431525)
<b>Date Licence applied for:</b>	15 March 2019
<b>Licence applied for:</b>	Licence to take water from a bore under section 60 of the <i>Water Act</i>
<b>Purpose for which Licence is sought:</b>	Petroleum activities
<b>Maximum quantity of water proposed to be taken annually for each beneficial use:</b>	
Petroleum Activities	175 ML p.a.
<b>Land from which water will be taken:</b>	NT Portion 1079 (8240 Carpentaria Hwy, Arnold),  NT Portion 7027 (4500 Carpentaria Hwy, Birdum).
<b>Land on which water will be used:</b>	NT Portion 702 (16965 Carpentaria Hwy, Pamayu),  NT Portion 1079 (8240 Carpentaria Hwy, Arnold),  NT Portion 7026 (14981 Stuart Hwy, Birdum),  NT Portion 7027 (4500 Carpentaria Hwy, Birdum).
<b>Bores from which water will be taken</b>	
	RN040895
<b>Water Source:</b>	Gum Ridge Formation
<b>Water Control District:</b>	Daly Roper Beetaloo Water Control District
<b>Declared Water Allocation Plan:</b>	No declared plan

### Reasons for Decision

#### *Procedural requirements*

3. I am satisfied that all substantive procedural requirements relating to the making of the Application have been met. This includes that:
- (a) the Application was duly made in the approved form and includes all information required under the Act and the Water Regulations 1992

(b) the Applicant is a legal entity

and

(c) the Applicant has the authority to access the land from which water is proposed to be taken under the Licence and on which the water will be used (**Land**).

4. Section 71B(1) of the Act provides that within 30 days after lodgement of an application to which Part 6A of the Act applies, the Controller must give notice of the Controller's intention to make a water extraction licence decision (**NOI**).
5. As the Application was accepted for lodgement on 20 March 2019, the NOI was required to be given by 19 April 2019. Accordingly, the NOI was published in the NT News on 22 March 2019 and in the Katherine Times on 27 March 2019.
6. Section 71B(2) of the Act requires a copy of the NOI to be published in a newspaper circulating throughout the Territory and provides that the NOI may also be published in a newspaper circulating in the general locality to which the application relates. To that extent, the NOI was published in the NT News and in the Katherine Times. A copy of the NOI as it appeared in the NT News and in the Katherine Times is provided at Attachment A.
7. The NOI complies with the requirements established by section 71B of the Act in relation to the content of the notice.<sup>1</sup>

***Provision of NOI to the owners and occupiers of adjacent land***

8. Section 71B(6) of the Act requires the Controller to give a copy of the NOI to owners and occupiers of land immediately adjacent to:
  - (a) the land from which the water will be taken
  - and
  - (b) the land on which the water will be used.
9. All owners and occupiers of land immediately adjacent to the Land which is the subject of the Application were identified by mapping tool NR Maps.
10. A copy of the NOI was sent to each owner and occupier of land adjacent to the Land.
11. The letters referred to in paragraph 10 were sent within 30 days of the lodgement of the Application.

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<sup>1</sup> Section 71B (3) of the Act sets out the general information that must be included in the NOI and s. 71B(4) requires the NOI to include an invitation to make written comments about an application to the Controller within 30 days after publication of the notice. The NOI includes all of that information.

12. Following the 30 day public consultation period the department became aware that land adjacent to the Land was the subject of a native title determination and that native title holders, who are also recognised as occupiers of the adjacent land, were not provided a copy of the NOI. Consequently, the native title holders, via the Northern Land Council, were provided a copy of the NOI on 14 May 2019.
13. Notwithstanding that the letter to the native title holders was sent outside the 30 day period specified in the Act, it is not considered that the delay would have any effect on the validity of a decision to grant the Licence or the Licence itself. That is because the native title holders were given 30 days in which to respond to the NOI and any response received has been taken into account in this assessment.

### ***Responses to NOI***

14. In response to the NOI, nine responses were received. A discussion about each response to the NOI is included below from paragraph 79.

### ***Decision-maker***

15. In accordance with section 18 of the Act, I was appointed the Controller of Water Resources (Controller) on 19 December 2016. That appointment remains current and there are no limitations on the terms of my appointment that would prevent me from deciding the Application.
16. Further, I am not aware of any personal or professional matter which may prevent me from deciding the Application.

## **ASSESSMENT UNDERTAKEN, EVIDENCE USED AND ADVICE**

### ***Assessment of relevant factors under s 90(1) of the Act***

17. Section 90(1) of the Act provides that in making a water extraction licence decision I must take into account any of the factors specified in that section that are relevant to the decision.
18. My decision about the Application is a water extraction licence decision.
19. The following is an assessment of this Application against each of the individual factors specified in section 90(1) of the Act:

#### ***(a) the availability of water in the area in question;***

20. The Applicant's proposed activity is located in the Daly Roper Beetaloo Water Control District (**District**) declared under section 22 of the Act.
21. The Land overlies the Gum Ridge Formation in the northern Georgina Basin and is outside of a water allocation plan area.

22. Availability of water from the area, in the absence of a declared plan, is informed by the Northern Territory Water Allocation Planning Framework (**Framework**). A copy of the Framework is provided in Attachment B.
23. The Framework is a written policy that has guided water allocation in the Territory for many years. The Application falls within the Arid Zone of the Northern Territory. In the Arid Zone, the Framework relevantly states there will be no deleterious change in ground water discharges to dependent ecosystems, and total extraction over a period of at least 100 years will not exceed 80 per cent of the total aquifer storage at start of extraction. It further provides that if current or projected consumptive use exceeds 80 per cent or ground water discharges to ground water dependent ecosystems are impacted, no new water extraction licences will be granted unless there is scientific evidence supporting the grant.
24. The Georgina Basin Groundwater Assessment: Daly Waters to Tennant Creek, Technical Report 17/2017<sup>2</sup> (Georgina Basin Report), reports the volume of ground water held in storage in the Gum Ridge Formation is estimated to be between 1,766,000 GL (gigalitres) and 3,532,000 GL.
25. In accordance with the Framework, total extraction over a period of at least 100 years should not exceed between 1,412,800 and 2,825,600 GL.
26. There is one water extraction licence in the Gum Ridge Formation, which authorises a total maximum extraction of 967.5 ML from the licensed period of May 2019 to December 2023.
27. The Application proposes to extract 175 ML per year for 3 years which equates to a total extraction for the term of the licence of 525 ML.
28. The total amount of ground water taken under a water extraction licence from May 2019 to December 2023 if this licence is granted would be 1,492.5 ML; significantly less than the estimated water available for extraction under the Framework.
29. With respect to ground water dependent ecosystems; ground water discharges from the Gum Ridge Formation are associated with the ground water dependent ecosystems of Bitter Springs and Rainbow Springs. Modelling activities undertaken by the department, as described in paragraph 37-42, conclude that the proposed extraction would have no change in reliability of spring flows at Bitter Springs or Rainbow Springs.
30. Based on the above information it appears sufficient water is available to meet the requirements of the Applicant.

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<sup>2</sup> Tickell, S.J. and Bruwer, Q, (2017) Georgina Basin Groundwater Assessment: Daly Waters to Tennant Creek, Technical Report 17/2017 (Version 2, April 2019), Northern Territory Department of Environment and Natural Resources. Northern Territory Government, Australia.

**(b) the existing and likely future demand for water for domestic purposes in the area in question;**

31. Land owners and occupiers have certain prevailing statutory rights under the Act to take water for domestic purposes. The demand for water in the District in the exercise of these statutory rights must be taken into account when determining the amount of water available to be taken for other purposes under water extraction licences.
32. The total land area of where water may be taken and where water may be used is around 13,000 square kilometres and is largely surrounded by pastoral leases. The Land is in a remote location via the Carpentaria Highway, south east of Daly Waters.
33. The Georgina Basin Report indicates there is limited demand for ground water for domestic water. Around 300 ML of water per year is estimated for domestic water use including around 100 ML for 25 homesteads and 200 ML from the Gum Ridge Formation for the township of Elliot.
34. Due to the remote location and pastoral land use in the area future domestic demand is unlikely to change significantly.
35. The existing and likely future demand for water for domestic purposes is therefore insignificant in comparison to volume of water available from the Gum Ridge Formation in accordance with the Framework.
36. In accordance with the definition of a petroleum activity, water used for domestic purposes by petroleum activity employees, contractors and associated workers is included as an ancillary use. For this reason, domestic water use associated with the petroleum activity, is included in the Application volume.

**(c) any adverse effects likely to be created as a result of activities under the permit, licence or consent on the supply of water to which any person other than the applicant is entitled under this Act;**

37. To assess whether the Applicant's maximum volume of water proposed to be taken would have an effect on the supply of water to which any person other than the Applicant is entitled, the department used the integrated Daly Roper ground water and surface water model (**Model**). The Model outputs were analysed to measure impacts by assessing the change in reliability of surface water flows and ground water discharge (or spring flows) and the reduction in ground water level.
38. Reliability of surface water flows were analysed at indicator sites located at Elsey National Park and Red Rock on the Roper River. The assessment indicated there would be no change in reliability of surface water flows at the specified indicator sites.

39. Spring flow (as a measure of ground water discharge) was assessed at two key sites: Bitter Springs and Rainbow Springs. The analysis determined there would be no change in reliability of spring flows at Bitter Springs or Rainbow Springs.
40. Ground water levels were assessed at eight registered bore locations at varying proximity for each of the nominated extraction points. A maximum reduction in ground water level of 0.12 metres after 58 years of continuous extraction was estimated at registered bores located 1.08 km from the nominated extraction point. This modelled impact on ground water level is significantly less than one metre reduction in ground water level specified in the Inquiry Report as “excessive”.
41. A copy of the Water Assessment Report detailing the analysis of the Model outputs can be found in Attachment C.
42. In summary, the water assessment indicates there will be no change in the reliability of surface water flows at the indicator sites and an insignificant reduction in ground water level. Therefore it is unlikely, that the proposed extraction of water will have any adverse effect on the quantity of water to which any person other than the applicant is entitled under the Act.
43. Any potential for an adverse effect could be monitored into the future by licence conditions which:
- limit the Applicant’s water usage
  - require the Applicant to report on its water usage
  - require the Applicant to monitor ground water level prior to extracting water and verify modelled estimates of ground water level draw down
  - prohibit the extraction of ground water within one kilometre of bores used for the purpose of stock and domestic use
  - report any contraventions of the terms and conditions of the licence.
44. Impacts on water quality, of stock and domestic users including the township of Elliot, will be monitored in association with the environment management plan required under the Petroleum (Environment) Regulations 2016 and the department’s Preliminary Guideline: Groundwater Monitoring Bores for Exploration Petroleum Wells in the Beetaloo Sub-basin (refer Attachment D).

***(d) the quantity or quality of water to which the applicant is or may be entitled from other sources;***

45. There is no other water source in the vicinity of the Applicant’s Land that could provide the necessary quantity and quality of water for the Applicant’s petroleum activities.

**(e) the designated beneficial uses of the water and the quality criteria pertaining to the beneficial uses;**

46. The quality criteria that apply to the water are outlined in Gazette Notice G15, 10 April 2019. Under section 22A of the Act the declared beneficial uses of all surface water from all natural waterways and all ground water located in the District are:

- Agriculture
- Aquaculture
- Public water supply
- Environment
- Cultural
- Industry
- Rural stock and domestic
- Mining activity
- Petroleum activity.

Petroleum activity is the listed beneficial use in the proposed Licence, consistent with the Applicant's business activity, and is listed in the section 22A declaration.

47. Further, under section 73(1), the objectives described in Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia, 2018 to be the objectives that apply in relation to the water in the District, according to the beneficial use of the water. These objectives will be monitored in association with the environment management plan required under the Petroleum (Environment) Regulations 2016 and the department's Preliminary Guideline: Groundwater Monitoring Bores for Exploration Petroleum Wells in the Beetaloo Sub-basin (refer Attachment D).

**(g) existing or proposed facilities on, or in the area of, the land in question for the retention, recovery or release of drainage water, whether surface or sub-surface drainage water;**

48. There are no known existing facilities on, or in the area of, the Land, for the retention, recovery, or release of surface or sub-surface drainage water.

49. The Applicant's proposed development will generate waste water through fracture stimulation flow back fluid, drilling mud, cuttings, drill fluid and domestic grade sewage from the camp site.

50. Waste management will be addressed in the Applicant's environment management plan and is also subject to regulation under the *Waste Management and Pollution Control Act 1998*. Environment management plans must be approved by the Minister for Environment and Natural Resources before activities commence.

51. To address any associated risks special conditions in the licence are included that limit the extraction water unless an approved environment management plan is in place.

**(h) the adverse effects, if any, likely to be created by such drainage water resulting from activities under the licence on the quality of any other water or on the use or potential use of any other land;**

52. The Applicant has indicated the waste water is likely to be stored temporarily on site before being transported offsite for treatment and disposal at a licensed waste handling facility.
53. Such matters will be addressed under an environment management plan and is also subject to regulation under the *Waste Management and Pollution Control Act 1998*.
54. Additionally, the Inquiry Report, Recommendation 7.17 states that any discharge of any onshore shale gas fracturing waste water (treated or untreated) to either drainage lines, waterways, temporary stream systems or waterways be prohibited. Under section 16 of the Act a discharge of this nature would be an offence unless permitted in a waste discharge licence. A waste discharge licence permitting such an activity would be contrary to the government's acceptance of the Inquiry Report. The Water Amendment Bill 2019, has been passed in Parliament to amend the Act to fulfil several key recommendations of the Inquiry Report, including enforcing recommendation 7.17 of the Inquiry Report.
55. To address any associated risks special conditions in the licence are included that limit the extraction of water unless an approved environment management plan is in place.

**(j) the provisions under the Planning Act 1999 relating to the development or use of land in the area in question;**

56. Under the Northern Territory Planning Scheme (**NTPS**), the Applicant's Land is zoned NOZONE (No NT Planning Scheme zone applies).
57. Clause 10.2 of the NTPS (Clearing of Native Vegetation) states that the clause does not apply if the clearing is required or controlled under any Act in force in the Territory. Land clearing is a regulated activity under the Petroleum (Environment) Regulations 2016 and managed under an environment management plan.
58. Planning controls relating to land in the immediate locality of the Applicant's Land have also been considered. From searches using mapping tool NR Maps it is evident that all adjacent properties are zoned NOZONE. Further, no proposed change to the zoning of the local area has been identified which may have the effect of impacting the supply of ground water for users such as the Applicant. Therefore this factor is not relevant to my decision.



**(k) other factors the Controller considers should be taken into account or that the Controller is required to take into account under any other law in force in the Territory.**

## **Bores**

59. The Applicant proposes to take water from one registered water bore. Additional bores are yet to be drilled.
60. The construction of the bore, was undertaken in association with the Applicant's environment management plan, NT EP 117 Water Bore Monitoring Program, approved by the Minister for Primary Industry and Resources on 10 December 2018, variation approved on 12 February 2019.
61. The environment management plan required the bores to be constructed in accordance with Minimum Construction Requirements for Water Bores in Australia, Edition 3. Mandatory requirement 11.1 of the standard requires that multiple aquifer bores must be sealed between the aquifers and permeable zones to prevent intermixing flow, and contamination of the aquifers.
62. A review of the statement of bore and gamma log undertaken by the department indicated the positioning of the cement plug did not isolate the aquifers of the Anthony Lagoon Formation and the Gum Ridge Formation. This is contrary to the requirements of the environment management plan and the Application which means any water extracted under a licence could not be directly attributed to the Gum Ridge Formation. It also means water would be extracted from the incorrect water source.
63. No water has yet been extracted from the bore and is working to rectify the bore construction. This work will be regulated under a bore work permit that has been issued to the Applicant.
64. To address the risks associated with the construction of the bores special licence conditions are included that requires the licence holder to demonstrate the bores are constructed in accordance with the Minimum Construction Requirements for Water Bores in Australia (Edition 3) prior to extracting ground water.

## **Final Report of the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory**

65. An independent Scientific Inquiry into Hydraulic Fracturing of Onshore Unconventional Reservoirs in the Northern Territory was commissioned to investigate the environmental, social and economic risks and impacts of hydraulic fracturing of onshore unconventional gas reservoirs and associated activities. This led to the publication of the Final Report of the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory in March 2018 (Inquiry Report). On 17 April 2018, the government accepted all 135 recommendations of the Inquiry Report. The government has developed an implementation plan that responds to the recommendations <https://hydraulicfracturing.nt.gov.au/implementation-plan>.

66. Recommendation 15.1 requires a strategic regional environment baseline assessment (SREBA) be undertaken prior to the granting of any further production approvals. Recommendation 7.19 and 7.20 require the SREBA to take into account ground water dependent ecosystems in the Roper River and identify and characterise all subterranean aquatic ecosystems, with a particular emphasis on the Roper River region.
67. The SREBA will be managed under an approved environment management plan in accordance with the Petroleum (Environment) Regulations 2016. This water extraction licence decision relates to ground water for exploration activities and should be made independently of the recommendations regarding the SREBA.
68. Recommendation 7.8 and 7.11 in the Inquiry Report are directly related to this licence decision.
69. Recommendation 7.8 requires that measures are mandated to ensure that any onshore shale gas development does not cause unacceptable local drawdown of aquifers. It states that the extraction of water from water bores to supply water for hydraulic fracturing be prohibited within 1km of existing or proposed groundwater bores (that are used for domestic or stock use). The Inquiry Report establishes a drawdown in excess of 1m as excessive. Recommendation 7.8 also states that gas companies be required, at their expense, to monitor drawdown in local water supply bores.
70. Recommendation 7.11 provides a list of items in order to minimise the risk of ground water contamination from leaky gas wells the majority of which will be regulated under an environment management plan. The item relevant to the licence decision, states that a minimum offset distance of at least 1km between water supply bores and well pads must be adopted unless site-specific information is available to support a lesser distance.
71. These recommendations are addressed in special licence conditions that:
- limit the Applicant's water use
  - require the Applicant to report on its water use
  - require the Applicant to monitor ground water level prior to extracting water and verify modelled estimates of ground water level draw down
  - prohibit the extraction of ground water within one kilometre of bores used for the purpose of stock and domestic use
  - report any contraventions of the terms and conditions of the licence
  - have an approved environment management plan in place.

## Ground water dependant ecosystems

72. The Potential for Groundwater Use by Vegetation in the Australian Arid Zone<sup>3</sup> provides a technical study on ground water dependent ecosystems predominately in the Ti Tree Basin, which may be applied to this area. This study indicates that terrestrial ground water dependent ecosystems generally access water to depths of 15 – 20 metres below ground level. The standing water level of the target aquifer ranges from 44 – 65 metres below ground level which is outside the reaches of terrestrial ground water dependent ecosystems.

## Licence period

73. In accordance the Act, a water extraction licence may be granted for a period, not exceeding ten years, as is specified in the licence. However I may grant a licence for a period exceeding ten years, where, in the opinion of the Minister, there are special circumstances that justify it under the Act.

74. The Minister has not provided advice regarding special circumstances that justify granting a licence for more than 10 years.

75. The Applicant has indicated a licence term expiring 31 December 2021.

## Prioritising Water Extraction Licence Applications Policy

76. In accordance with the policy Prioritising Water Extraction Licence Applications, applications for new or increased water extraction licences are processed on a first in first served basis sequenced in order of the date and time of lodgement of the application for each water resources area within a water control district.

77. This Application is the only outstanding application lodged with the department for processing in the area of the Gum Ridge Formation and therefore has priority over any other application in this water resource area.

78. The following factors are not relevant to my decision:

- *Section 90(1) (ab)* - Section 22B (4) of the Act provides that water resource management in a water control district is to be in accordance with a declared water allocation plan. There is no declared plan area in which the Applicant's Land is located.
- *Section 90(1) (f)* - there is currently no such agreement.

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<sup>3</sup> Cook, P.G. and Eamus, D, The Potential for Groundwater use by Vegetation in the Australian Arid Zone, March 2018,

**Comments received in response to NOI or from third parties generally**

79. As previously stated, nine comments were received in response to the NOI.

80. I am required to consider each response provided within the statutory timeframe for comment when deciding to grant the Application.

81. In the following table is a summary of the issues raised (which extracts the key text from the submission) and the response.

Name of person responding	Owner or occupier of Adjacent land?	Summary of issues raised in submission	Consideration of issues raised
Jacqui Cannon of Consolidated Pastoral Company	Yes	<p>The submission raises the issues of the use of water and the effects on food producers.</p> <p>The submission states that:</p> <p>“...Water should be taken first wherever possible from the water that is a by-product from mining and after this, from depths not accessed by food producers now and that will not be accessed by food producers in the future...”</p> <p>“...Water taken should not be from water sources that interacts with water used now and in the future by food producers...”</p>	<p>This response raises issues which are extraneous to my decision. However indicate concern regarding the availability and protection of water resources which are relevant and need to be weighed in my decision against the other matters that would support the grant of the decision.</p> <p>Matters relating to water availability have been considered in paragraphs 20-30 and 45.</p> <p>The impact on other water uses has been considered in paragraphs 37-44.</p> <p>The Application has been assessed in accordance with the prioritising water extraction licence applications policy detailed in paragraphs 76-77.</p>

Justin Tutty	No	<p>The submission raises issues regarding the appropriate assessment of on-shore gas activities, the implementation of the recommendations of the <i>Final Report of the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory (Inquiry Report)</i> and the protection of ground water dependent ecosystems.</p> <p>The submission states that:</p> <p>“...pre-emptive allocation related to fracking are neither being pursued nor processed in good faith...”</p> <p>“...is an attempt to evade appropriate assessment of on-shore gas exploitation.”</p> <p>“...the recommendations of the Pepper Inquiry require any fracking approvals to be grounded in SREBA – strategic regional assessments that must include a survey of groundwater dependant ecosystems...”</p> <p>“... this proponent is racing against reform, attempting to weight an eventual assessment with the inevitability of approvals granted without the benefit of the imminent regional assessment...”</p>	<p>This response raises issues which are relevant and need to be weighed in my decision against the other matters that would support the grant of the decision.</p> <p>The <i>Final Report Scientific Inquiry into Hydraulic Fracturing in the Northern Territory</i> and the recommendations from this report and the issues relating to the SREBA have been considered as addressed above in paragraphs 65 - 71.</p> <p>Ground water dependent ecosystems are relevant to the considerations and been considered in paragraphs 23, 29 and 72.</p>
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<p>Amelia Telford of Seed Indigenous Youth Climate Network</p>	<p>No</p>	<p>The submission raises concerns with limited information available and consultation periods and concern about the potential damages of fracking.</p> <p>The submission states that:</p> <p>“...the lack of information regarding this water licence, the lack of consultation and inaccessible process for comment from those most likely to be impacted that is our main concern...”</p> <p>“...without being provided with adequate information, time and resources, many of these communities are unable to have their concerns heard and questions answered”</p> <p>“...request additional time, including a consultation period and process, is allowed for Traditional Owners, Aboriginal communities and appropriate cultural authorities for the area impacted by this licence...”</p>	<p>This response raises issues which are relevant and need to be weighed in my decision against the other matters that would support the grant of the decision.</p> <p>The <i>Water Act 1992</i> specifies the public notice and consultation requirements when making a water extraction licence decision. The Act also specifies the content of such notices. The publishing of the notice and consultation periods provided were in accordance with the requirements of the Act. The public viewing at the Office is consistent with current practices.</p> <p>Extensive public consultation was undertaken in the preparation of the <i>Final Report Scientific Inquiry into Hydraulic Fracturing in the Northern Territory</i> and the recommendations from this report have been considered as addressed above in paragraphs 65 - 71.</p>
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<p>Raymond Dixon, Thelma Dixon, Shannon Dixon, Annette Kingston, Regina Kingston, Johnny Devlin, Susan Kingston of Protect Country NT</p>	<p>No</p>	<p>The submission raises concerns relating to the protection of water resources, the impact of water extraction and water availability.</p> <p>The submission states that:</p> <p>“...We are concerned about the amount of water that Origin Energy is applying to take for its exploration program because of the impacts it could have on our water security, and the health of our communities, culture and environment...”</p> <p>“...as Aboriginal custodians we have land rights, but what good are they if we don't have rights to control and protect our water? It is the foundation for all life and our culture...”</p> <p>“...stop new extraction for dangerous and wasteful fracking...”</p>	<p>This response raises issues which are relevant and need to be weighed in my decision against the other matters that would support the grant of the decision.</p> <p>The availability of water in this area has been substantively addressed above in assessing factor 90(1)(a) in paragraph 20 - 30</p> <p>Any adverse effects likely to be created has been substantively addressed above in assessing factor 90(1)(c) in paragraph 37 - 44</p> <p>The environmental assessment of on-shore gas activities are undertaken in accordance with the Petroleum (Environment) Regulations 2016.</p>
<p>Naomi Hogan of Lock the Gate Alliance</p>	<p>No</p>	<p>The submission raises issues regarding limited information available to the public and consultation periods and future activities by the Applicant.</p> <p>The submission states that:</p> <p>“...we are concerned there is limited information available to the public on the aquifer that will be targeted, the number of bores that will be</p>	<p>This response raises issues which are relevant and need to be weighed in my decision against the other matters that would support the grant of the decision.</p> <p>The <i>Water Act 1992</i> specifies the public notice and consultation requirements when making a water extraction licence decision. The Act also specifies the content of such notices. The publishing of the notice and</p>



		<p>required, and the number of fracking wells that will be services by this water...”</p> <p>“... Clear information should be available about what Origin intends to do with the water and more hydrological information should have been made available...” and “many landholders in the NT are remote and cannot easily access offices in Alice Springs, Katherine or Darwin...”</p> <p>“...Future activities if approved for Origin would involve hundreds of fracking wells, requiring massive volumes of water...” and “...the risks and impacts involved in this process are only going to escalate...”</p> <p>“...call on the Department to re-advertise the Origin water licence application...”</p>	<p>consultation periods provided were in accordance with the requirements of the Act The public viewing at the Office is consistent with current practices.</p> <p>Extensive public consultation was undertaken in the preparation of the <i>Final Report Scientific Inquiry into Hydraulic Fracturing in the Northern Territory</i> and the recommendations from this report have been considered as addressed above in paragraphs 65 - 71.</p> <p>The water extraction licence decision relates to the Application. Should the Applicant wish to increase extraction beyond the maximum extraction limit volume of 175 ML p.a., a new application will need to be submitted and assessed in accordance with the Act.</p>
Heidi Jennings	No	<p>The submission raises issues regarding making decisions pending legislative amendments, <i>Final Report of the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory</i> (Final Report), and water availability.</p> <p>The submission states that:</p> <p>“... Legislation Amendments and Bills are currently still in the process of being rectified.</p>	<p>This response raises issues which are relevant and need to be weighed in my decision against the other matters that would support the grant of the decision.</p> <p>The <i>Water Act 1992</i> specifies the processes that must be undertaken when making a water extraction licence decision. These processes mean that the Controller is not able to refuse a water extraction licence</p>

	<p>This water extraction license should not be accepted at this point in time...”</p> <p>“... The Fracking Inquiry suggested for further investigations on the ground water dependent ecosystems. The 135 recommendations were to be implemented, prior to the Industry being developed in the NT...”</p> <p>“...granting of licenses should only occur when the industry ensures there is no evidence, worldwide, that hydraulic fracturing or UCG, will not affect the quality or quantity of the water, the environment, or cause any systemic activity. There is inadequate evidence to safely enable any high-risk activities to the NT water...”</p> <p>“...Water tables and Aquifer levels are dropping severely and Recharge is unlikely due to a lack of rainfall. Alice Springs area is in drought and has had little rainfall...”</p> <p>“...The basic human right to clean water is being compromised...”</p>	<p>application and must make a decision within a specified timeframe.</p> <p>In making a decision other factors relevant to the decision are taken into account. To that extent it would be premature to consider legislation amendments that have not yet been settled by the government.</p> <p>The recommendations of the <i>Final Report Scientific Inquiry into Hydraulic Fracturing in the Northern Territory</i> have been considered as well as Baseline Testing under the SREBA as detailed in paragraphs 65 - 71</p> <p>The resource information has been substantively addressed above in assessing factor 90(1)(a) in paragraphs 20 - 30.</p> <p>Any adverse effects likely to be created has been substantively addressed above in assessing factor 90(1)(c) in paragraphs 37 - 44.</p>
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<p>Pauline Cass of Protect NT Inc.</p>	<p>No</p>	<p>This submission raises concerns regarding the timing of the application with respect to pending amendments to the Water Act 1992, the cumulative impacts of water extraction in the region, triggers for water restrictions, and the information available on the Water Licensing Portal.</p> <p>The submission states that:</p> <p>“... Origin have jumped the gun by applying for a water extraction licence before the new amendments to the Water Act (NT) have been implemented, thereby avoiding the restrictions and penalty increases the new Water Act would place on their activities. For this alone, this application must be denied...”</p> <p>“...The Pepper Inquiry’s “Recommendation 14.19” states that, “Cumulative impacts of petroleum and other activities in the region must be considered by a decision-maker...”</p> <p>“... We are also concerned that there are still no water restriction triggers in the Water Act (NT) to protect our groundwater resources during times of drought. The Northern Territory has experienced its driest wet season which has left many of our aquifers at depleted levels. With our changing</p>	<p>This response raises issues which are relevant and need to be weighed in my decision against the other matters that would support the grant of the decision.</p> <p>The <i>Water Act 1992</i> specifies the processes that must be undertaken when making a water extraction licence decision. These processes mean that the Controller is not able to refuse a water extraction licence application and must make a decision within a specified timeframe.</p> <p>In making a decision other factors relevant to the decision are taken into account. To that extent it would be premature to consider legislation amendments that have not yet been settled by the government.</p> <p>The recommendations of the <i>Final Report Scientific Inquiry into Hydraulic Fracturing in the Northern Territory</i> have been considered as well as Baseline Testing under the SREBA as detailed in paragraphs 65 - 71</p> <p>The resource information has been substantively addressed above in assessing factor 90(1)(a) in paragraphs 20 - 30.</p> <p>The Water Licensing Portal displays the details contained within the notice of intent to</p>
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		<p>climate, drought restrictions must be included in water licences...”</p> <p>“... People need and have a right to more information regarding applications than what is currently provided in the Water Licensing Portal...”</p>	<p>make a water extraction licence decision. Once a decision is made, further information becomes available relating to the licence granted including the statement of decision.</p>
<p>Graeme Sawyer of Protect Country Alliance NT</p>	<p>No</p>	<p>This submission raises concerns regarding baseline data being available on a public register and the availability of information and consultation periods.</p> <p>The submission also raised questions regarding the sustainable year published without a time period and the target aquifer for water extraction.</p> <p>The submission states that:</p> <p>“... we object to the allocation of this water Licence...” and “....request that the water licence application is readvertised. Updated, corrected and more detailed information should be provided to the public...”</p> <p>“... Why was the figure representing the sustainable yield published without a time period</p>	<p>This response raises issues which are relevant and need to be weighed in my decision against the other matters that would support the grant of the decision.</p> <p>The <i>Water Act 1992</i> specifies the public notice and consultation requirements when making a water extraction licence decision. The Act also specifies the content of such notices. The publishing of the notice and consultation periods provided were in accordance with the requirements of the Act</p> <p>The department’s Water Data Portal provides public access to water quality and quantity data which is updated every month and water quality statistics updated every quarter. Further, Government is developing an online portal to enable timely public reporting and ongoing monitoring associated with Inquiry</p>

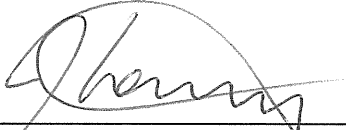
		<p>component...” and “...To publish a figure as a yield without a time element is misleading...”</p> <p>“...Can you also explain the changed figures on page 44 of the 2017 Tickell and Brewer report...”</p> <p>“... In the spirit of the fracking inquiry recommendations, the supporting documents and baseline data should be held on a public register...”</p> <p>“... We have strong concerns about the way in which the information was presented in the ad and the lack of information available on the online portal...”</p> <p>“... It is critical that the department gets the processes correct from the outset, as the risks and impacts involved in this process are only going to escalate...”</p>	<p>report as addressed above in paragraphs 65 - 67</p> <p>The 2017 Tickell and Brewer report contained a typographical error in one section. When this was identified the report was immediately corrected. The resource information has been substantively addressed above in assessing factor 90(1)(a) in paragraphs 20 - 30.</p>
<p>Marion Scrymgour of Northern Land Council (NLC) (representing native title holders)</p>	<p>Occupier</p>	<p>This submission does not object to the grant of the water extraction licence, however raises broader concerns relating to the potential issuing of multiple water extraction licences throughout and adjacent to the Beetaloo Basin.</p> <p>The submission states that:</p> <p>“...With the onshore gas industry in its infancy within the Beetaloo Basin region, it is timely to</p>	<p>This response raises issues which are relevant and need to be weighed in my decision against the other matters that would support the grant of the decision.</p> <p>The integrated Daly Roper surface water and ground water assessment model uses historical water extraction data and climatic conditions to predict the impact of proposed water extraction into the future. The model</p>

		<p>reflect on how groundwater extraction and use could potentially impact on Indigenous people and sites that are significant to them...”</p> <p>“...Groundwater can be a subsurface feature of sacred sites, and example of which is the springs around Mataranka and the associated swamp habitats/environments...”</p> <p>“...The issuing of water extraction licences also has potential to impact on the management of Strategic Indigenous Water Resources...”</p> <p>“...NLC believes a great deal of work needs to be undertaken prior to the granting of further water extraction licences in the region so that accurate baseline data can be obtained...”</p> <p>“...Further water extraction licences should be made reference to groundwater modelling that included consideration of the cumulative impacts...” and “...account for the potential impacts of climate change...”</p>	<p>considers cumulative impact of all water extraction and is used to predict impacts relating to ground water discharge in springs in the Mataranka area including Bitter Springs and Rainbow Springs as addressed in paragraph 29 and 37 - 44.</p> <p>The comment relating to Strategic Water Reserves is extraneous to the issues I need to consider. The Northern Territory Government has made steps to legislate Strategic Aboriginal Water Reserves. This will apply when a water allocation plan is in place. Water allocation planning will be undertaken for areas of the Beetaloo basin as outlined in the recommendations of the <i>Final Report of the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory</i>.</p>
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82. Other than the responses to the NOI, there has been no contact with any third party in relation to the Application.

**Conditions of Licence**

83. The conditions of the Licence reflect my decision and the discussion above.



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JOANNE TOWNSEND  
CONTROLLER OF WATER RESOURCES

11 June 2019

## DOCUMENTS PROVIDED WITH THIS DECISION

<b>Attachment</b>	<b>Description</b>
A.	NOI as it appeared in the NT News and in the Katherine Times
B.	Northern Territory Water Allocation Planning Framework
C.	Water Assessment Report
D.	Preliminary Guideline: Groundwater Monitoring Bores for Exploration Petroleum Wells in the Beetaloo Sub-Basin



30 CLASSIFIEDS

FRIDAY MARCH 22 2019

Notices

General Notices

DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

Notice of intention to make a water extraction licence decision (Pursuant to section 71B of the Water Act)

The Controller of Water Resources hereby gives notice that a decision is to be made regarding an application for a grant of a new water extraction licence under section 60 of the Water Act for the proposed beneficial use - petroleum activities, associated with petroleum exploration permit 76, 98 and 117.

The source of extraction for the application in Table 1 is the Gum Ridge Formation for which the estimated sustainable yield is not yet determined but is in the range of 1,412,800 to 2,825,600 gigalitres. The total quantity of water that may be taken from this groundwater resource under existing water extraction licences is 0 ML/year. The total quantity of water that currently is taken from the water resource under water extraction licences is 0 ML/year.

Table 1

Table with 5 columns: Name, Property where water is taken, Property where water is used, Registered bore number, Maximum annual extraction (ML/year)

Comments regarding this application should be made in writing by COB 26 April 2019 to the Controller of Water Resources, PO Box 496, Palmerston NT 0831 or email water.licensing@nt.gov.au

Further information is available at www.waterresources.nt.gov.au/licenceportal

www.nt.gov.au/water



APPLICATIONS LODGED FOR ASSESSMENT UNDER THE PLANNING ACT

DEVELOPMENT APPLICATIONS

DARWIN

PALMERSTON

Map and details for Darwin application: Lots 1515 & 1516, 7 & 5 Searcy Street, Lot 7118, 47 Cavenagh Street, Town of Darwin.

Map and details for Darwin application: ALDENHAM RD, SAUNDERS ST, STANLEY ST, Lots 12103 & 12104, Town of Nightcliff, 7 & 5 Stanley Street, Muirhead.

Map and details for Palmerston application: STUART HWY, TOUPEIN RD, Lot 7058, Town of Palmerston, 19 Toupein Road, Yarrawonga.

CLOSING DATE FOR SUBMISSIONS FRIDAY 5th APRIL 2019 4:00 PM CST (or 12 MIDNIGHT CST if lodged online at: www.ntlis.nt.gov.au/planning)

Applications may be inspected at Development Assessment Services, First Floor, Energy House, 18-20 Cavenagh Street, Darwin or viewed online through the Planning Notices online.

Submissions must be lodged by the closing date indicated in order to be considered by the consent authority. Submissions in relation to an application must be in writing and include the name and postal address of the author and may be made publicly available in full.

Submissions may be lodged with Development Assessment Services, Department of Infrastructure, Planning and Logistics, GPO Box 1680, Darwin NT 0801, hand delivered to First Floor, Energy House, 18-20 Cavenagh Street, Darwin or lodged online through Planning Notices online.

For enquiries phone: 8999 6046 or fax: 8980 0700

website: www.ntlis.nt.gov.au/planning

DEPARTMENT OF INFRASTRUCTURE, PLANNING AND LOGISTICS



MEGA MONDAY CROSSWORD SOLUTION

Crossword solution grid with words filled in, including: FOREFRONT, GIG, ENCLOSURES, T, P, REDOUBLED, U, I, V, RIOTOUS, O, N, PARTAKE, E, P, I, I, MOVES, E, A, N, N, CROSSPIECE, A, R, S, P, PASTA, I, EXTORTION, T, U, E, T, E, M, INTROVERT, G, GENIUS, D, N, OVOID, PRICES, DOPES, R, R, RESIN, A, D, INERT, U, O, R, C, T, Y, L, INAPT, N, O, TOWERED, R, ERRS, MATERIAL, SETA, I, SCRAPES, E, M, O, ASIDE, A, T, I, I, INANE, O, U, I, DRIBBLED, M, M, VETERINARIAN, G, M, NETWORKS, S, O, HAPPENED, E, C, USHERING, E, G, ATTITUDE, E, D, I, SCORCH, R, R, N, EFFLUENT, W, N, N, RELAYRAGE, L, L, LIVESDOWN, O, R, R, A, EVOLVE, T, U, TALISMANIC, G, I, DRUDGE, A, R, I, IAN, STUMP, R, N, I, O, GRAVE, EON, E, I, DESTITUTE, I, P, ASSESSMENT, E, A, FRATERNAL, E, E, L, E, GASED, A, E, M, EATEN, A, R, S, E, DRY, STYLE, N, DEGRADES, A, N, ARMED, BAR, A, PROSE, FANTASY, U, A, SMALLER, IDIOT, D, V, I, R, A, F, U, N, I, N, NEXT, P, A, R, N, S, I, M, I, N, R, A, L, T, NIGH, A, A, E, R, E, D, H, D, I, N, GROWN, CALLING, A, S, RESIGNS, EMERY, R, PEG, WASTE, E, E, DISHEVEL, E, TIRED, PEP, U, S, V, I, ADDER, I, T, I, SPADE, M, D, D, A, NASTINESS, R, O, DISBELIEVE, X, T, PAINFULLY, C, R, ARE, AGILE, R, E, M, E, PITHY, RUE, G, A, H, VALISE, U, T, TOURNAMENT, A, I, AMAZON, B, E, F, L, DIVERSION, A, E, DIALECTIC, R, U, L, REVERSAL, A, A, P, STAINS, T, L, O, HESITATE, O, A, INUNDATE, E, S, HEREUPON, N, L, FRICTION, N, I, WELLDESERVED, C, E, INSTALLS, I, G, E, GATES, I, O, I, G, TIDED, E, O, U, TRESSES, T, SHOT, CONTEMPT, EAST, P, THREWUP, T, T, AVERT, R, C, M, V, E, C, F, ELIDE, L, R, IDEAS, R, L, INCUR, SCREEN, REFER, L, N, PASTE, N, GYMNASIUM, H, E, A, L, U, R, AMENDMENT, M, GESE, C, E, A, A, ATTRIBUTES, O, T, P, E, ADAGE, U, S, L, E, RETURNS, E, D, TANNERS, R, S, I, L, POTPLANTS, E, D, EVERGREENS, T, D, YESTERDAY

Legal Notices

Form 888 Rule 88.09 NOTICE OF INTENDED APPLICATION FOR PROBATE In the Supreme Court of the Northern Territory of Australia. After 14 days from publication of this notice an application for probate of the Will dated 20 February 2015 of JANINA SZYC late of Tiwi Gardens Aged Care, Tiwi in the Northern Territory of Australia, formerly of 59 Jingili Terrace, Jingili in the aforesaid Territory, Retired Hospital Worker, deceased, will be made by DAVID PIOTR SZYC. Creditors are required to send particulars of their claims upon her estate to WARD KELLER, Lawyers, GPO Box 330, Darwin, NT, 0801.

NOTICE OF LOST TITLE Would anyone holding or knowing the whereabouts of the duplicate certificate as to title Volume 696 Folio 238 for Section 03278 Hundred of Glyde in the name of: Coolalinga Holdings Pty Ltd (ACN 085 321 455) as Trustee for the Coolalinga Property Trust please contact Darwin Family Law, Level 3/9 Cavenagh Street Darwin NT on 89461666.

NOTICE OF LOST TITLE Would anyone holding or knowing the whereabouts of the duplicate certificate of title comprised in Volume 008 Folio 056 Lot 291 Townsite of Southport in the name of: William Eddrup Adcock, please contact Carmen Jap at Minter Ellison Lawyers, GPO Box 1134, Darwin NT 0801 or 08 8901 5941.

NOTICE OF LOST TITLE Would anyone holding or knowing the whereabouts of certificate of title Volume 736 Folio 733 Lot 1350 Town of Tennant Creek (8 Griggs Street Tennant Creek) registered in the name of Outback Stores Pty Ltd (ACN 120 661 234), please contact, Coralie at Bowden McCormack Lawyers + Advisers Suite 4 Level 1 Northgate Plaza 101 Mitchell Street Darwin or GPO Box 2644 Darwin NT 0801 Email conveyancer@bowden-mccormack.com.au Phone 08 89 416355. Fax: 08 89 416366.

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Positions Vacant



**ROPER GULF REGIONAL COUNCIL**  
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Prerequisite for employment with Roper Gulf Regional Council you must obtain the following:  
 • Hold a valid driver's licence and class 1 or 2 licence as a requirement of employment with RGRCC  
 • Be an Australian Resident or possess the current relevant visa to work in Australia

Located in a stunning part of the Northern Territory, Roper Gulf Region offers a unique lifestyle. The Regional Council covers an area approximately the size of Victoria and is serviced by five major river systems. Career opportunities with the Roper Gulf Regional Council include:

**Position Title: CDP Senior Employment Consultant**  
**Location: Katherine**  
**Position Type: Casual**  
**Salary Range:** Level 5 indicative \$64,676.63 to \$71,391.16 per annum based on 38 hours per week, (negotiated based on qualifications and experience) plus 25% casual loading  
**Closing Date:** Midnight on Sunday, 14 April 2019  
**End Date:** 30 June 2019  
**Application Requirements:** RGRCC Job Application Form, statement addressing the selection criteria and resume/CV sent to recruitment@ropergulf.nt.gov.au

**COUNCIL RESIDENTS ENCOURAGED TO APPLY**

The Roper Gulf Regional Council has a friendly, progressive and professional work environment with fantastic working conditions that include the following benefits, 6 weeks annual leave + 17.5% loading (pro-rata for part time employees), 10 days personal leave, tax benefits (relating to Zone A), travel allowances and ongoing professional development and training.

[www.ropergulf.nt.gov.au](http://www.ropergulf.nt.gov.au)

Public Notices

**Katherine Umpires Association**  
**Annual General Meeting**  
 Knotts Crossing Resort  
**Wednesday 3<sup>rd</sup> April at 7.00 PM**  
 All Welcome  
**Contact: Daryl Grahek 0400 448 513**

**HELEN SUMMERS OPTOMETRIST**  
 Helen Summers will be consulting in Katherine on 4<sup>th</sup> & 5<sup>th</sup> of April, Gorge Health, 11 Second Street Katherine. Helen Summers offers Professional Eye examinations and assessments for Contact Lenses, Pre & Post Laser treatments as well as Reading and Learning Development Preferred Medibank Supplier  
**Please phone 8995 8595 for an appointment**


Public Notices

**GREEN Snaps Nature Photography Competition.** Entries for Green Snaps close on 4 May. The 2019 theme is 'New Life in the NT Environment'. Download an entry form from Katherine Start Page [www.webpage-nt.com](http://www.webpage-nt.com). Call 0408 440 696 for more information.

**STAND OUT!!**  
 ADD COLOUR TO YOUR AD

Public Notices

**APPLICATIONS LODGED FOR ASSESSMENT UNDER THE PLANNING ACT**  
**DEVELOPMENT APPLICATIONS**  
**KATHERINE**



Quarry Road  
 Lansdowne Road  
 GORGE ROAD

N.T. Portion 6606  
 187 Lansdowne Road, Lansdowne  
 N.T. Portion 07154  
 180 Quarry Road, Lansdowne  
 Subdivision and consolidation to create two lots  
 Earl James and Associates

N.T. Portion 4739  
 595 Gorge Road, Lansdowne  
 Restaurant within a defined flood area  
 Carolyn Grace

**CLOSING DATE FOR SUBMISSIONS WEDNESDAY 3<sup>rd</sup> APRIL 2019 4:00 PM CST**  
 (or 12 MIDNIGHT CST if lodged online at: [www.ntlis.nt.gov.au/planning](http://www.ntlis.nt.gov.au/planning))


Applications may be inspected at Development Assessment Services, Katherine Government Centre, 5 First Street, Katherine or viewed online through the Planning Notices Online: [www.ntlis.nt.gov.au/planning](http://www.ntlis.nt.gov.au/planning)

Submissions **must** be lodged by the closing date indicated in order to be considered by the consent authority. Submissions in relation to an application must be in writing and include the name and postal address of the author and may be made publicly available in full.

Submissions may be lodged with Development Assessment Services, Department of Infrastructure, Planning and Logistics, PO Box 2390, Katherine NT 0851, hand delivered to Katherine Government Centre, 5 First Street, Katherine or lodged online through Planning Notices Online: [www.ntlis.nt.gov.au/planning](http://www.ntlis.nt.gov.au/planning)

For enquiries phone: 8973 8926 or fax: 8973 8944 website: [www.ntlis.nt.gov.au/planning](http://www.ntlis.nt.gov.au/planning)

**DEPARTMENT OF INFRASTRUCTURE, PLANNING AND LOGISTICS**



**NORTHERN TERRITORY GOVERNMENT**

Public Notices

**DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES**

**Notice of intention to make a water extraction licence decision (Pursuant to section 71B of the Water Act)**

The Controller of Water Resources hereby gives notice that a decision is to be made regarding an application for a grant of a new water extraction licence under section 60 of the Water Act for the proposed beneficial use - petroleum activities, associated with petroleum exploration permit 76, 98 and 117.


The source of extraction for the application in Table 1 is the Gum Ridge Formation for which the estimated sustainable yield is not yet determined but is in the range of 1,412,800 to 2,825,600 gegalitres. The total quantity of water that may be taken from this groundwater resource under existing water extraction licences is 0 ML/year. The total quantity of water that currently is taken from the water resource under water extraction licences is 0 ML/year.

**Table 1**

Name	Property where water is taken	Property where water is used	Registered bore number	Maximum annual extraction (ML/year)
Origin Energy B2 Pty Ltd	NT Portion 1079 NT Portion 7027	NT Portion 702 NT Portion 1079 NT Portion 7026 NT Portion 7027	RN040895	175

Comments regarding this application should be made in writing by COB 26 April 2019 to the Controller of Water Resources, PO Box 496, Palmerston NT 0831 or email [water.licensing@nt.gov.au](mailto:water.licensing@nt.gov.au)  
 Further information is available at [www.waterresources.nt.gov.au/licenceportal](http://www.waterresources.nt.gov.au/licenceportal)

[www.nt.gov.au/water](http://www.nt.gov.au/water)



**NORTHERN TERRITORY GOVERNMENT**

**APPLICATION LODGED FOR ASSESSMENT UNDER THE PLANNING ACT**  
**EXCEPTIONAL DEVELOPMENT APPLICATION**  
**1st ADVERTISEMENT**



The Minister for Infrastructure, Planning and Logistics has received an application for an Exceptional Development Permit for the purpose of Fuel Depot on NT Portion 5437 (40) Emungalan Road, Emungalan.

The land is within Zone LI (Light Industry) of the Northern Territory Planning Scheme and the development of the site for Fuel Depot would otherwise be prohibited.

**CLOSING DATE FOR SUBMISSIONS WEDNESDAY 10 APRIL 2019 4:00PM CST**


Applications may be inspected at Development Assessment Services, Katherine Government Centre, 5 First Street, Katherine or viewed online through the Planning Notices Online: [www.ntlis.nt.gov.au/planning](http://www.ntlis.nt.gov.au/planning)

Submissions **must** be lodged by the closing date indicated in order to be considered by the consent authority. Submissions in relation to an application must be in writing and include the name and postal address of the author and may be made publicly available in full.


Submissions may be lodged with Development Assessment Services, Department of Infrastructure, Planning and Logistics, PO Box 2390, Katherine NT 0851, hand delivered to Katherine Government Centre, 5 First Street, Katherine or lodged online through Planning Notices Online: [www.ntlis.nt.gov.au/planning](http://www.ntlis.nt.gov.au/planning)

For enquiries phone: 8973 8926 or fax: 8973 8944 website: [www.ntlis.nt.gov.au](http://www.ntlis.nt.gov.au)

**DEPARTMENT OF INFRASTRUCTURE, PLANNING AND LOGISTICS**




**NORTHERN TERRITORY GOVERNMENT**



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**Fairfax Media**

# Northern Territory Water Allocation Planning Framework

All available scientific research directly related to environmental and other public benefit requirements for the water resource will be applied in setting water allocations for non-consumptive use as the first priority, with allocations for consumptive use made subsequently within the remaining available water resource.

In the absence of directly related research, contingent allocations are made for environmental and other public benefit water provisions and consumptive use. These are explained below.

## Top End (northern one third of the Northern Territory)

### Rivers

At least 80 per cent of flow at any time in any part of a river is allocated as water for environmental and other public benefit water provision, and extraction for consumptive uses will not exceed the threshold level equivalent to 20 per cent of flow at any time in any part of a river.

In the event that current and/ or projected consumptive use exceeds the 20 per cent threshold level, new surface water Licences will not be granted unless supported by directly related scientific research into environmental other public benefit requirements.

### Aquifers

At least 80 per cent of annual recharge is allocated as water for environmental and other public benefit water provision, and extraction for consumptive uses will not exceed the threshold level equivalent to 20 per cent of annual recharge.

In the event that current and/ or projected consumptive use exceeds the 20 per cent threshold level, new groundwater Licences will not be granted unless supported by either directly related scientific research into groundwater dependent ecosystem/ cultural requirements, or in the absence of such research, hydrological modelling confirming that total groundwater discharge will not be reduced by more than 20 per cent.

## Arid Zone (southern two thirds of the Northern Territory)

### Rivers

At least 95 per cent of flow at any time in any part of a river is allocated as environmental and other public benefit water provision, and extraction for consumptive uses will not exceed the threshold level equivalent to five per cent of flow at any time in any part of a river.

In the event that current and/ or projected consumptive use exceeds the threshold levels of five per cent for river flow, new surface water Licences will not be granted unless supported by directly related scientific research into environmental other public benefit requirements.

## Northern Territory Water Allocation Planning Framework

### Aquifers

There will be no deleterious change in groundwater discharges to dependent ecosystems, and total extraction over a period of at least 100 years will not exceed 80 per cent of the total aquifer storage at start of extraction.

In the event that current and/ or projected consumptive use exceeds the threshold levels of 80 per cent of the consumptive pool for aquifers, or groundwater discharges to groundwater dependent ecosystems are impacted, new groundwater Licences will not be granted unless supported by directly related scientific research into groundwater dependent ecosystem/cultural requirements.

# Water Assessment Report to Water Licensing and Regulation Branch

## 1. References

TRIM Record Number : LRM2019/0036-0008~0001  
Title : Modelling and analysis request - Origin

## 2. Information Provided

Appendix 1 contains the revised version of the request received from the Water Licensing and Regulation Branch. Subsequent communication with licencing staff clarified the Origin GWEL pumping scenarios as follows:

Scenario 2

Bore	Rate	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
RN040895	ML/Month	0.0	6.4	11.0	5.3	6.0	11.0	13.0	14.3	13.3	4.7	0.3	0.0
RN_Site2	ML/Month	0.0	0.0	0.0	0.0	6.0	11.7	11.7	7.7	9.7	14.0	19.0	10.0

Scenario 3

Bore	Rate	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
RN040895	ML/Month	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	46.5	41.1	0.0
RN_Site2	ML/Month	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	46.5	41.1	0.0

Scenario 2 and 3 are two combinations of maximum annual pumping of 175 ML/y

## 3. Metadata

### 3.1 Model Versions

Four scenarios were run with the updated Roper model (M11-G3).

A new version of the model is generated with each pumping scenario application. These were named as:

- i. **ORIGIN\_SC0 modified\_Rech\_03\_G.fem** for modelling natural flow;
- ii. **ORIGIN\_SC1\_ modified\_Rech\_03\_G.fem** for current use scenario; and
- iii. **ORIGIN\_SC2 modified\_Rech\_03\_G.fem** and **ORIGIN\_SC3 modified\_Rech\_03\_G.fem** for the two Origin pumping scenarios, above.

The resultant outputs were compared to the natural (no-pumping) scenario output for impact assessment.

It should be noted that climate data used was identical to that used for the 2018 Announced Allocations and thus was current until March 2018.



#### **4. Statement of model uncertainty**

The Roper groundwater model used in this process is considered an adequate basis to guide licensing decisions. The output should be treated with the understanding and acceptance of the limitations associated with the modelling process.

An analysis of model calibration is provided in Knapton (2006) and a three part documentation of the Roper Model (Knapton, 2009) which cover the groundwater, surface water and connected models. In the analysis, the author identifies the model's sensitivities to the various hydraulic parameterisation. However, this analysis is qualitative, and any resulting uncertainty is not quantified. The author identifies inherent sources of uncertainty which include the variability in spatial distribution of recharge and the difficulty in quantifying it as well as the empirical nature of soil property data, vegetation water use and ground elevation data. These all contribute to the uncertainty in the final output from the model.

A broad based review by Middlemis (2015) provides peer assessment that this model applies best practice approaches to model conceptualisation, development and calibration. Although it is recognised that this model's construction pre-dates the Australian Groundwater Modelling Guidelines (Barnett et al, 2012), it is considered to have "*overall good compliance with the guideline principles*" (Middlemis, 2015).

The estimation of the various inputs and model parameters contributes to a level of uncertainty in the final output. However, it is envisaged that model outputs will be refined over time as groundwater system knowledge, and the quality and completeness of input data improves.

#### **5. Model output summary**

Two pumping scenarios to represent the possible options for extraction at bores RN040895 and Site 2 were modelled. These scenarios are named SC2 and SC3.

For the purpose of the licence assessment, the Roper model output was interrogated for:

- (a) Resultant impact on flows at these following key indicator sites on the Roper River:
  - i. Eley National Park (near flow gauge G9030176); and
  - ii. Red Rock (near flow gauge G9030250).
- (b) There are no registered bores screened within the Gum Ridge Formation aquifer located within a 10 km radius of either

pumping bores. Potential drawdown impacts were assessed at approximate radial distances (based on nearest model node) of

- i. 1 km (north, south, east and west)
  - ii. 10 km (north, south, east and west)
- (c) Resultant impact on flows at these following key spring discharge sites as represented in the model
- iii. Rainbow Springs
  - iv. Bitter Springs

The model output will be stored in the folder named [results](#) (use link) for a period of no less than 6 months after a decision is made. Subsequently, it will be deleted. The output can be regenerated if so required.

## 6. Model output Analysis

- (a) Resultant impact on flows at the key indicator sites of Elsey National Park (G9030176) and Red Rock (G9030250).

The analysis of the model's river flow output is undertaken in the spreadsheet: *Analysis of Flow for Origin\_Energy\_Application-LRM2019-0036-0008.xlsx* located [here](#) (use link).

The analysis determines that there is **no change** in reliability of surface water flow at the indicator sites as provided in Table 1 below.

**TABLE 1 Change in Reliability of Surface water flow**

Location	Change in Reliability	
	SC2	SC3
Elsey National Park (G9030176)	nil	nil
Red Rock (G9030250)	nil	nil

- (b) Drawdown impacts due to proposed pumping.

The analysis of the model's hydraulic head data output is undertaken in the spreadsheet: *Drawdowns.xlsx* located [here](#) (use link). The licence application proposed three years of pumping. The modelled scenarios SC2 and SC3 represented 58 years of continuous pumping.



The estimated drawdown at approximately 1 and 10 km under Modelled Scenario SC2, relative to Modelled Scenario SC1 (current conditions), are provided in Table 2 below.

**TABLE 2 Estimated drawdown due to pumping under Modelled Scenario SC2**

<b>Distance from pumping bore (direction)</b>	<b>Model node number</b>	<b>Estimated drawdown (m) after three years of pumping</b>	<b>Modelled drawdown (m) after 58 years consecutive pumping</b>
<b>RN040895</b>			
1.06 km (north)	48759	0.003	0.007
1.11 km (south)	46725	0.003	0.007
1.09 km (east)	47941	0.003	0.007
1.06 km (west)	50349	0.003	0.007
10.27 km (north)	49101	0.001	0.004
10.17 km (south)	47750	0.001	0.004
10.14 km (east)	45892	0.001	0.004
10.87 km (west)	45749	0.001	0.004
<b>Site 2</b>			
1.08 km (north)	51298	0.064	0.112
1.18 km (south)	47444	0.055	0.103
1.08 km (east)	52708	0.064	0.113
1.20 km (west)	51422	0.056	0.103
9.95 km (north)	45948	0.000	0.025
10.08 km (south)	45985	0.000	0.022
10.15 km (east)	50802	0.000	0.024
10.35 km (west)	47065	0.000	0.022

The estimated drawdown at approximately 1 and 10 km under Modelled Scenario SC3, relative to Modelled Scenario SC1 (current conditions), are provided in Table 3 below.

**TABLE 3 Estimated drawdown due to pumping under Modelled Scenario SC3**

Distance from pumping bore (direction)	Model node number	Estimated drawdown (m) after three years of pumping	Modelled drawdown (m) after 58 years consecutive pumping
<b>RN040895</b>			
1.06 km (north)	48759	0.006	0.010
1.11 km (south)	46725	0.007	0.010
1.09 km (east)	47941	0.006	0.010
1.06 km (west)	50349	0.006	0.010
10.27 km (north)	49101	0.001	0.004
10.17 km (south)	47750	0.001	0.004
10.14 km (east)	45892	0.001	0.004
10.87 km (west)	45749	0.001	0.004
<b>Site 2</b>			
1.08 km (north)	51298	0.079	0.126
1.18 km (south)	47444	0.067	0.114
1.08 km (east)	52708	0.079	0.127
1.20 km (west)	51422	0.070	0.116
9.95 km (north)	45948	0.000	0.025
10.08 km (south)	45985	0.000	0.022
10.15 km (east)	50802	0.000	0.023
10.35 km (west)	47065	0.000	0.021

(c) Resultant impact on flows at two key spring discharge sites as represented in the model.

The analysis of the model's springflow output is undertaken in the spreadsheet:

*md\_WORKING\_Altered Spring Flows\_ORIGIN Application.xlsx*  
located [here](#) (use link)

The analysis determines that there is **no change** in reliability of springflow as provided in Table 4 below.

**TABLE 4 Change in Reliability of Springflow at two key sites**

<b>Bitter Springs</b>	<b>Existing Licences</b>	<b>SC2</b>	<b>SC3</b>
Restricted Years 1/1/1988-31/12/2017	0	0	0
Unrestricted Years	30	30	30
Reliability	100%	100%	100%

<b>Rainbow Springs</b>	<b>Existing Licences</b>	<b>SC2</b>	<b>SC3</b>
Restricted Years 1/1/1988-31/12/2017	0	0	0
Unrestricted Years	30	30	30
Reliability	100%	100%	100%

## 7. Water Management Context

The licence application is within the Gum Ridge Formation in the northern Georgina Basin. There is no Water Allocation Plan current in this area. At this location, the ESY is presumed to be based on application of the NT Water Allocation Framework policy for the Arid Zone.

Tickell and Bruwer (2017) reports the volume of groundwater held in storage in the Gum Ridge Formation across the Georgina Basin is estimated to be between the limits as provided in the table below:

Minimum groundwater volume (GL)	Maximum groundwater volume (GL)
1,766,000	3,532,000

## 8. References

Barnett, B., Townley, L.R., Post, V., Evans, R.E., Hunt, R.J., Peeters, L., Richardson, S., Werner, A.D., Knapton, A. and Boronkay, A. (2012). Australian Groundwater Modelling Guidelines. Waterlines report 82, National Water Commission, Canberra. URL: <http://archive.nwc.gov.au/library/waterlines/82>.

Knapton, A., 2006, Regional Groundwater Modelling Of the Cambrian Limestone Aquifer System Of the Wiso, Georgina and Daly Basins, Water Resources Report 29/2006, Land and Water Division, Department of Natural Resources, Environment and the Arts, Alice Springs.

- Knapton, A., 2009, Gulf Water Study : An Integrated Surface – Groundwater Model Of The Roper River Catchment, Northern Territory, Part A - Coupled Surface – Groundwater model, Water Resources Report number 15/2009, Department of Natural Resources, Environment, The Arts & Sport, Darwin.
- Knapton, A., 2009, Gulf Water Study : An Integrated Surface – Groundwater Model Of The Roper River Catchment, Northern Territory, Part B – MIKE11 Surface Water Model, Water Resources Report number 31/2009, Department of Natural Resources, Environment, The Arts & Sport, Darwin.
- Knapton, A., 2009, Gulf Water Study : An Integrated Surface – Groundwater Model Of The Roper River Catchment, Northern Territory, Part C – FEFLOW Groundwater Model, Water Resources Report number 32/2009, Department of Natural Resources, Environment, The Arts & Sport, Darwin.
- Middlemis, H. (2015). Roper Basin Modelling Methodology Review, Report D0853, Prepared by Hydrogeologic Pty Ltd for Northern Territory Department of Land Resource Management, April 2015.
- Tickell, S. J. and Bruwer, Q. (2017) Georgina Basin Groundwater Assessment: Daly Waters to Tennant Creek, Technical Report 17/2017, Northern Territory Department of Environment and Natural Resources. Northern Territory Government, Australia.

**(d) Appendix 1 - Licence Assessment Modelling and Analysis Request**



DEPARTMENT OF ENVIRONMENT AND

**LICENSING ASSESSMENT MODELLING AND ANALYSIS REQUEST**

Site 2  
 Easting: 435488.000 Northing: 8136321.000  
 Latitude: -16° 51' 20.13525" Longitude: 134° 23' 39.84654"  
 Grid Convergence: 0° -10' 32.18" Point  
 Scale: 0.99965146

**1. Request**

Undertake modelling and analysis to determine what if any impact the ground water take from the Gum Ridge Formation Aquifer.

**2. Licence application**

This request for modelling and analysis supports the processing of:

- a new groundwater extraction licence with a maximum entitlement of 175 ML p.a. (based on a May-April water accounting year) from the Gum Ridge Formation Aquifer

**3. Data provided**

The following information is provided for modelling and analysis purposes.

- Application for a groundwater extraction licence including the Water Use Plan and proposed extraction schedule for 2019-2022.

**4. Background information**

To summarise information contained within the application:

- Proposed extraction is from RNO40895 (Site 1) and a proposed bore with approximate location 435488E, 8136321N Zone 53 (Site 2).
- Proposed extraction from two separate sites within NT Portion 7027 and NT Portion 1079
- Proposed 10 future bore locations targeting the Gum Ridge Formation. As the applicant is not committing to the use of these bores and the bores have not been constructed, further analysis or consideration of extraction from these sites are not relevant from a licensing perspective.
- Maximum monthly use from the three bores is 90 ML;
- Combined maximum annual entitlement of 175 ML.

PROPOSED PUMPING SCHEDULE 2019			
Month	Extraction from Site 1 - RNO40895 (ML)	Extraction from Site 2 - 435488E, 8136321N Zone 53	Total volume (ML)
Jan	0	0	0
Feb	0	0	0
Mar	0	0	0

LICENSING ASSESSMENT MODELLING AND ANALYSIS REQUEST

Apr	0	0	0
May	10	0	10
Jun	10	0	10
Jul	2	19	21
Aug	6	15	21
Sep	19	4	23
Oct	14	5	19
Nov	1	20	21
Dec	0	14	14
Total	62	77	139

PROPOSED PUMPING SCHEDULE 2020			
Month	Extraction from Site 1 - RN040895 (ML)	Extraction from Site 2 - 435488E, 8136321N Zone 53	Total volume (ML)
Jan	0	0	0
Feb	19	0	19
Mar	13	0	13
Apr	4	0	4
May	4	0	4
Jun	19	20	39
Jul	16	12	28
Aug	16	4	20
Sep	0	4	4
Oct	0	16	16
Nov	0	16	16
Dec	0	16	16

Total	91	88	179
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PROPOSED PUMPING SCHEDULE 2021			
Month	Extraction from Site 1 - RN040895 (ML)	Extraction from Site 2 - 435488E, 8136321N Zone 53	Total volume (ML)
Jan	0	0	0
Feb	0	0	0
Mar	20	0	20
Apr	12	0	12
May	4	18	22
Jun	4	15	19
Jul	21	4	25
Aug	21	4	25
Sep	21	21	42
Oct	0	21	21
Nov	0	21	21
Dec	0	0	0
Total	103	104	207

#### 5. Modelling scenarios

The application requests for flexibility in extracting **90 ML** in any month, limited to a maximum annual extraction of 175 ML (if referring to a May-April water year). Modelling will need to reflect the projected extraction from the two different sites listed in the table above. **Suggest extraction is projected using a 50% split between bore RN040895 and coordinates: 435488E, 8136321N Zone 53, over the driest months Oct/Nov.**

Additionally another modelling scenario will need to reflect the proposed pumping schedule, as detailed in the table above.

6. Licensing Assessment Report

A modelling and analysis report prepared by Water Assessments Branch in consultation with the Planning and Engagement Branch is required by: **5 April 2019**

The report should be prepared in consultation with the Water Planning and Engagement Branch.

This report should include:

- A summary of the model outputs.
- Estimated total sustainable yield of the subject water resource.
- Interpretation on how the analysis of model outputs relates to the NT Water Allocation Planning Framework (NTWAPF).
- Reliability and draw down effect. Noting that the Hydraulic Fracturing Inquiry recommendations describe more than 1 metre drawdown as excessive.
- Effect encompassing all relevant groundwater and surface water systems to predict any impacts on downstream users.
- Should there be any adverse effects, suggestions for alternative proposals that will fit into the NTWAPF.
- Any other information you deem relevant.

Copies of data output and analysis files and the final reports should be saved in TRM file: **LRM2019/0036-0013**.

REQUESTING OFFICER      JO CHALLIS      21 MARCH 2019



## **Preliminary Guideline: Groundwater Monitoring Bores for Exploration Petroleum Wells in the Beetaloo Sub-basin**

### **1. Purpose and Scope**

This preliminary guidance provides information on the expectations of the Department of Environment and Natural Resources (DENR) in relation to the layout, construction and operation of “multi-level observation bores” associated with onshore petroleum wells during the exploration phase of onshore gas development in the Beetaloo Sub-basin.

It is expected that principles in this preliminary guideline will be incorporated into Codes of Practice for the Northern Territory Onshore Petroleum Industry currently being developed by the Northern Territory Government. The requirements in this initial guidance, and subsequently under the Codes, may evolve following a period of operational experience during the exploration phase of the industry and as baseline understanding of the hydrogeological systems improves.

This preliminary guidance will be revised prior to any application to production-level activity.

This preliminary guidance was developed for the Beetaloo Sub-basin and additional guidance will be developed as required to account for different hydrogeology and environmental conditions in other gas basins. Additional guidance will also be developed for conventional petroleum activities.

The guideline relates specifically to monitoring bores established for the purpose of meeting recommendations 7.11 and 7.13 of the *Final Report of the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory, 2018* (the Report), noting that water bores may be established for a range of other purposes.

### **2. Background**

Groundwater monitoring bores must be established to detect any contamination of groundwater as a result of leaky gas wells or onsite spills, in order to meet the recommendations of the Report, specifically:

*Recommendation 7.11 (in part)*

*That prior to the grant of any further exploration approvals, in order to minimise the risk of groundwater contamination from leaky gas wells:*

- *Where a well is hydraulically fractured, monitoring of groundwater be undertaken around each well pad to detect any groundwater contamination using multi-level observation bores to ensure full coverage of the horizon, of any aquifer(s) containing water of sufficient quality to be of value for environmental or consumptive use;*
- *All existing well pads are to be equipped with multilevel observation bores;*
- *As a minimum, electrical conductivity data from each level of the monitor bore array should be measured and results electronically transmitted from the well pad site to the regulator as soon as they are available.*
- *Other water quality indicators, as determined by the regulator, should be measured quarterly, with the results publicly disclosed online as soon as reasonably practical from the date of sampling.*

**Preliminary Guideline:**  
**Groundwater Monitoring Bores for Exploration Petroleum Wells in the Beetaloo Sub-Basin**

*Recommendation 7.13*

*Upon a gas company undertaking any exploration activity or production activity, monitoring of the groundwater must be implemented around each well pad to detect any groundwater contamination, adopting the monitoring outlined in Recommendation 7.11. If contamination is detected, remediation must commence immediately.*

The rationale for these recommendations is further described in the Report (sections 7.6.1 and 7.6.3) and this detail has informed the guideline, notably:

*The Panel's view is that monitoring of key water quality indicators in the groundwater in close proximity (that is within 10-20 m) to each planned well or well pad is essential, and that this monitoring should commence prior to any well drilling, with subsequent monitoring being particularly focussed on the hydraulic fracturing stages. To this end, multi-level monitoring bores must be installed in advance (at least six months) prior to the drilling of a gas well and designed to ensure full vertical coverage of any aquifer(s) currently supplying, or potentially being able to supply, water for environmental or consumptive (stock or domestic) uses. The bore array must have a level of vertical resolution at least sufficient to be able to identify whether a leak of fluid or gas is occurring in the top, middle or bottom zones of an aquifer. At a minimum, electrical conductivity should be measured in real-time as an indicator providing 'early warning' of contamination, with the results telemetered from the site to the regulator and made available to the public. The use of telemetry for other parameters should be reviewed every five years or as technological improvements become available. Additionally, other water quality indicators determined by the regulator must be measured quarterly, with the results made publicly available within one month of sampling. The combination of continuous and randomised spot monitoring should continue for three years, after which time its fitness for purpose should be reviewed by the regulator.*

*If the electrical conductivity or other measurements suggest that a leak has occurred, or is occurring, more detailed investigations must commence immediately, with remediation to be initiated as soon as practicable. Parameter values for setting action thresholds should be determined from the data collected during the SREBA, and reviewed periodically by the regulator.*

*The text above specifically refers to the installation and monitoring of all new exploration wells. However, there are already a number of exploration wells (including the Amungee NW-1H well) that exist. The Panel recommends that these wells also require the installation of multilevel bores prior to the approval of either first time or repeat hydraulic fracturing activity.*

In developing the guidance, a precautionary approach has been applied at this early stage of shale gas exploration in the Northern Territory, which reflects the Inquiry Report and is appropriate given the lack of comprehensive scientific knowledge and extensive data regarding the stratigraphy and water quality of the Cambrian limestone aquifers across the Beetaloo Sub-basin. The guideline has been developed to ensure that scientific information on the stratigraphy and water quality of aquifer units that may be present at each petroleum exploration well site is established prior to the drilling of petroleum wells. This information will further inform the design of petroleum wells to ensure application of best available techniques to isolate and protect identified aquifer units at each site. Implementation of the guideline will also provide a large amount of spatial information about water quality of these important regional aquifers over time. It has also been developed to ensure that a robust groundwater monitoring system is developed to meet the recommendations and intent of the Inquiry, without being excessively onerous for industry in the exploration phase.

The primary water quality indicator recommended by the Inquiry Panel is electrical conductivity (E.C.). A review of ground water quality data across the Beetaloo Sub-basin from data sets with a broad spatial distribution and spanning several years indicates that E.C. is highly variable spatially, and

**Preliminary Guideline:**

**Groundwater Monitoring Bores for Exploration Petroleum Wells in the Beetaloo Sub-Basin**

perhaps temporally depending on location. Consequently, monitoring of E.C., and its constituents (e.g. Total Dissolved Solids and Chloride) needs to be site-specific to provide a meaningful baseline.

### **3. Summary of aquifer unit monitoring requirements**

Three main configurations of CLA (Cambrian limestone aquifers) are recognised overlying the Beetaloo Sub-Basin (Figure 1). These can be used as a preliminary guide for planning groundwater monitoring at well sites.

Each configuration is described below.

1. Aquifers in both the Anthony Lagoon and Gum Ridge Formations (or equivalents) are present: The depth to the base of the CLA sequence should be greatest in this zone. Each formation should be monitored with separate monitoring bores. Along the margins of this zone the Anthony Lagoon Formation may lie above the water table and so will not contain any aquifers. In such cases only the Gum Ridge Formation needs to be monitored.
2. Only the Gum Ridge Formation (or equivalent) is present: This formation should be monitored.
3. No aquifers present: This occurs mainly west of Larrimah where the Tindall Limestone (a Gum Ridge Fm. equivalent) lies above the water table. In such situations the uppermost aquifer in the Kalkarindiji Suite should be monitored. This formation occurs directly beneath the Tindall Limestone.

The water supply bore for the exploration well should be drilled to the base of the Gum Ridge Formation (or equivalent). Together with down-hole logs such as gamma and caliper this will enable more accurate identification of aquifers in the CLA sequence. The detailed design of the monitoring program at each well site is likely to be specific to that site, so consultation with DENR Water Assessment Branch is recommended following the drilling of the water supply bore.

The guide above indicates that a minimum of one and a maximum of two aquifer units would be monitored at each site, unless site-specific data clearly indicates no groundwater is present.

Where no groundwater is encountered at the proposed well pad site during the drilling of the water supply bore, the results should be provided to DENR Water Assessment Branch. In this circumstance, an exemption for the requirement to install groundwater monitoring bores at the proposed exploration well pad will be considered by DENR providing there has been an adequate attempt to locate groundwater.

Table 1 below provides a summary of requirements which are detailed in sections 4 to 6.

**Preliminary Guideline:  
Groundwater Monitoring Bores for Exploration Petroleum Wells in the Beetaloo Sub-Basin**

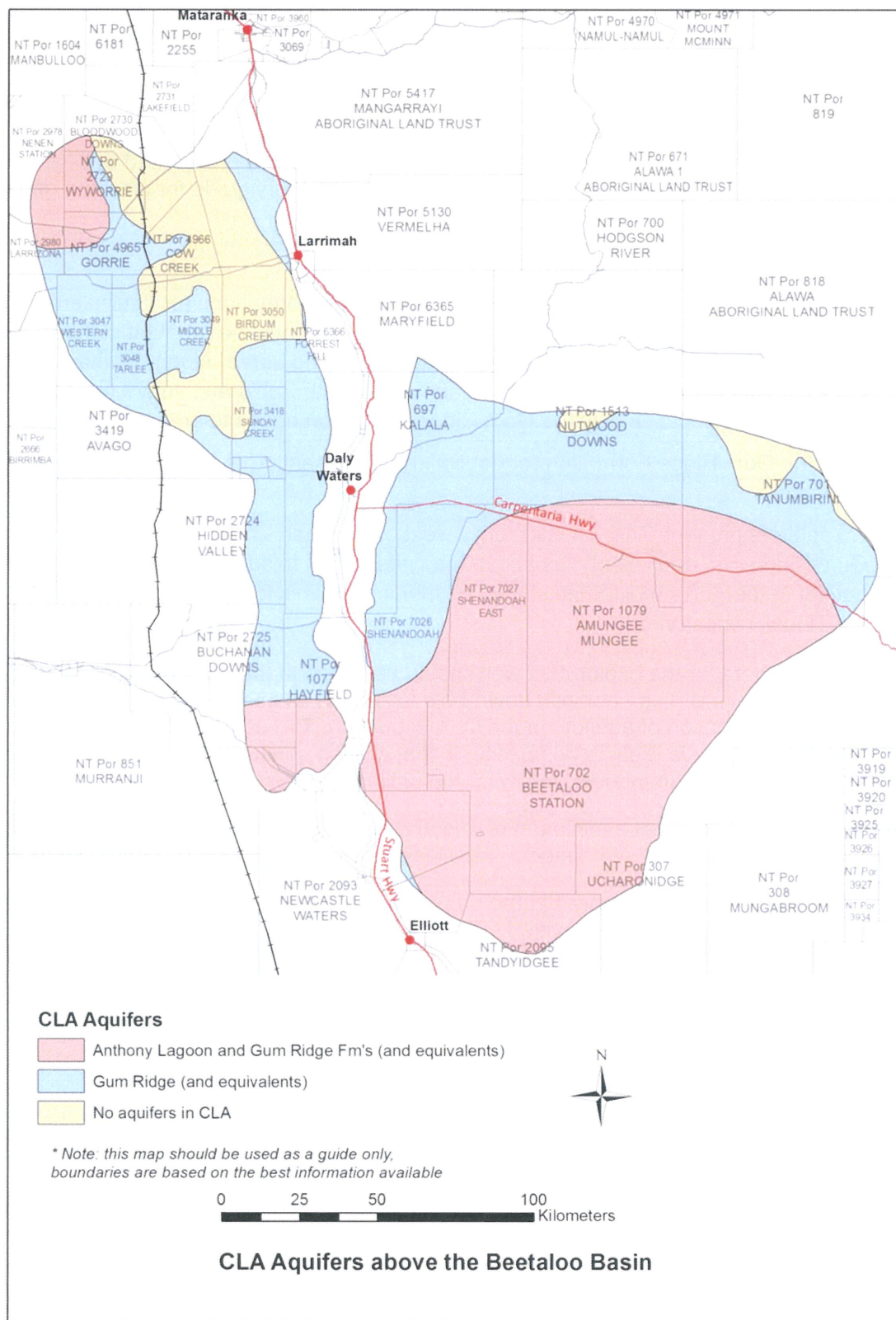


Figure 1 Indicative spatial location of Cambrian Limestone Aquifer units above the Beetaloo Basin

**Groundwater Monitoring Bores for Exploration Petroleum Wells in the Beetaloo Sub-Basin**

Table 1 – Monitoring bore requirements summary for petroleum exploration wells in the Beetaloo sub-Basin (see sections 4 to 6 for more detail)

Monitoring bore array type	Bore levels required	Possible Beetaloo solution	Location	When required
Control monitoring bore array. <i>Note this may include the production bore if water is to be sourced at the well site location.</i>	1 bore for each discrete aquifer unit, which is screened near the top, middle and bottom of the vertical extent of that unit	1 bore screened near the top, middle and bottom of the Anthony Lagoon formation at well sites where it is determined to occur; <b>and</b> 1 bore screened near the top, middle and bottom of the Gum Ridge formation; <b>or</b> 1 bore screened in the uppermost aquifer in the Kalkarindiji Suite where the Tindall limestone lies above the water table (ref. Sec. 2.3)	Within 100m up-gradient of the well pad	6 months prior to drilling, and preferably to include both wet season and dry season samples. In circumstances, which lie outside of the control of the operator, where six months monitoring data from the control bore is not achievable before drilling, it must at minimum provide six months of data prior to hydraulic fracturing activities
Impact monitoring bore array	1 bore for each discrete aquifer unit, which is screened near the top, middle and bottom of the vertical extent of that unit	As above	Within 20m down-gradient of the petroleum well. Where multiple exploration wells on a well pad are proposed then a single array, 20m down-gradient of the well head-series	At completion of well drilling and prior to hydraulic fracturing of the well. <i>It is acknowledged that installing this bore array prior to drilling the well may not be possible due to safety reasons.</i>

**4. Layout of groundwater monitoring bores**

The minimum requirements for monitoring bores in relation to detecting “leaky wells” is based on Before-After-Control-Impact (BACI) environmental monitoring design. BACI designs are an effective method to evaluate natural and human-induced perturbations of environmental variables (e.g. groundwater quality) when treatment sites cannot be randomly chosen, as is the case in this application. Groundwater monitoring bores to detect potential Impact from “leaky wells” should be located so that any contamination is detected as soon as possible, in a time frame that allows an effective remediation response. Groundwater flow gradients in the Cambrian Limestone Aquifer (CLA) are likely to be low in most parts of the Beetaloo Basin, and DENR believes that monitoring in close proximity (20m) of each well is essential for this purpose. If multiple exploration wells are planned for a single pad, DENR believes that monitoring within 20m downstream of the most proximate well in the series is sufficient.

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An appropriate BACI design has been determined to be as follows (also see Figure 2 for a diagrammatic representation):

1. A **Control monitoring bore array** (one or two depending on the discrete aquifer units present at the site), located up-gradient and within 100m of the planned or existing location of the petroleum well pad. This should be installed at least six months prior to drilling of the well and will provide site-specific, baseline ground water quality information. Wherever possible, pre-drilling data should include both wet season and dry season sampling. In circumstances, which lie outside of the control of the operator, where six months monitoring data from the control bore is not achievable before drilling, it **must** provide at minimum six months of data prior to hydraulic fracturing activities. The site-specific aquifer system information derived from drilling the Control monitoring bore array will also inform the subsequent design of the Impact monitoring bore array. It will also provide a basis for understanding natural trends that may occur at the site and therefore help differentiate between background and project-attributable changes over extended timeframes. The control array may also provide useful information about the spatial extent of impacts if a severe perturbation is detected in the impact array.
2. An **Impact monitoring bore array**, screened at similar depths to the **Control monitoring bore array**, 20m down-gradient of the location of the petroleum well. It is acknowledged that installing this bore array prior to drilling the well may not be possible due to safety reasons. Therefore the array may be installed after completion of drilling the petroleum well but must be installed and sampled prior to hydraulic fracturing. Where multiple exploration wells are proposed on a single well pad, either as part of a single drilling campaign or a later infill campaign, then a **single impact monitoring bore array** must be installed and sampled prior to hydraulic fracturing of any well in the series. This bore array must be located within 20m down gradient of the first well in the proposed **series**. and wherever possible this should be at the downgradient end of the series

Where subsurface geohazards are encountered during the drilling of the exploration petroleum well that may present elevated risks to the installation of an Impact monitoring bore array within 20m of the well, the location of the impact monitoring bore array may be varied on a case-by-case basis with approval from DENR.

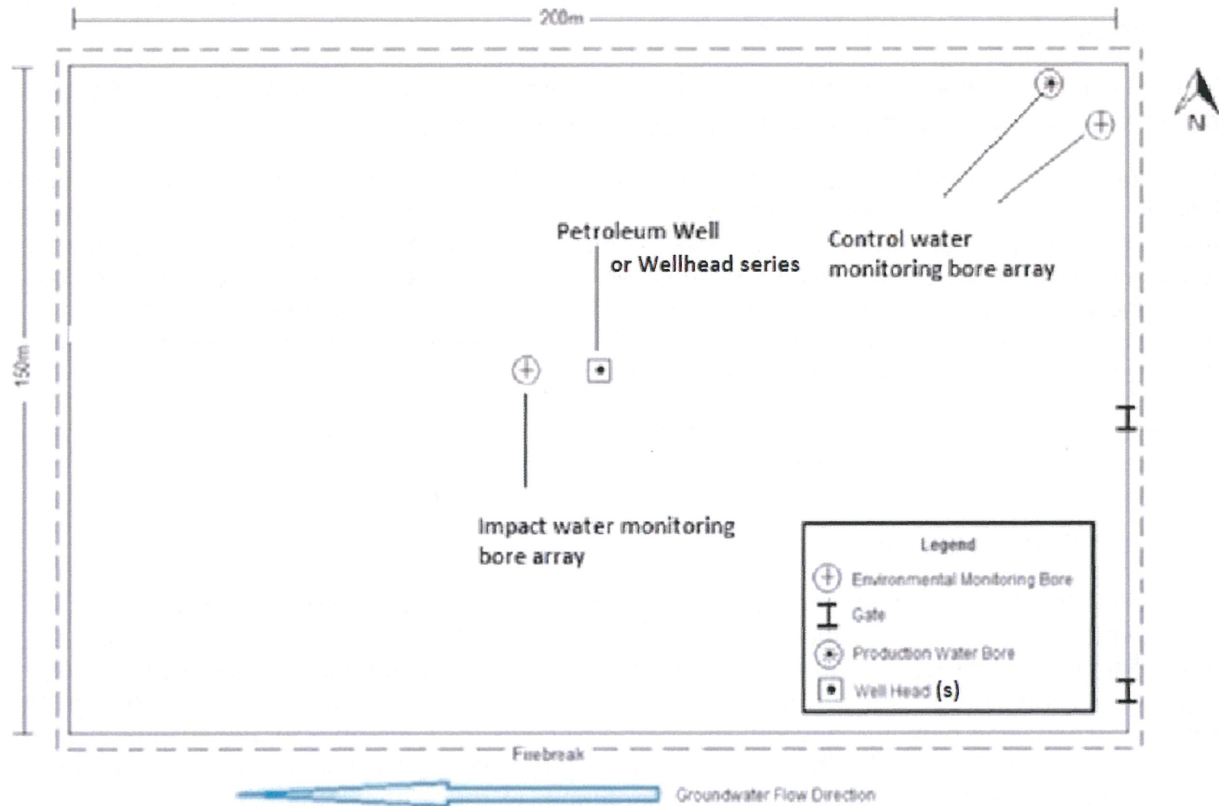


Figure 2: Indicative environmental groundwater monitoring bore layout on a petroleum well pad. Groundwater flow (gradient) direction in this example is from R-L of layout.

## 5. Design of monitoring bores

Monitoring bores should be established and screened to sample water in each aquifer unit (i.e. each non-interconnected formation) “currently supplying, or potentially being able to supply, water for environmental or consumptive (stock or domestic) uses”. The spatial variability of presently recognised aquifer units above the Beetaloo Sub-Basin are outlined in Figure 1. The design of the monitoring program at each well site is likely to be specific to that site, so consultation with DENR Water Assessment Branch regarding number of aquifer units and suitable screening depths is recommended following the drilling of the water supply bore. If water is not to be sourced at the well site, the first Control monitoring bore should be drilled to the base of the deepest recognised aquifer unit to provide the required stratigraphy data.

The appropriate number of bores and screening depths for each monitoring bore array will be site-dependent. Each Control monitoring bore and corresponding Impact monitoring bore should be screened at similar depths in the distinct aquifer units at that site. To provide vertical coverage of the aquifer unit that it samples, each monitoring bore should be screened near the top, middle and bottom of the vertical extent of that aquifer unit (or continuously as appropriate). DENR recognises that is overly onerous, and increases environmental risks, to require separate monitoring bores to be established at each sampling depth within each aquifer unit. Rather, an integrated sample should be collected from each Control monitoring bore and Impact monitoring bore for each aquifer unit in a way that maximises the probability of detecting any leak. Should a leak be detected, other techniques will be applied to determine the source level within the aquifer unit.

Where two monitoring bores are required in a monitoring bore array, the bores should be placed approximately 10m apart in a line approximately perpendicular to the flow gradient. In the unlikely event that three monitoring bores were required in a monitoring bore array, two bores should be placed as per the two-bore scenario, with an additional bore placed downgradient and 10m from the

other two bores. It is acknowledged that this will result in the third bore being approximately 28m from the petroleum well.

Bores must be constructed in accordance with Minimum Construction Requirements for Water Bores in Australia, 2012 (<https://www.adia.com.au/documents/item/290>).

An accurate drilling and lithological log of rock strata should be kept for all operations on the drill site. A clean representative sample of the rock formations intersected should be collected at all changes of strata and at a maximum drill depth intervals of three metres. Samples should be laid out in an orderly sequence for inspection and a report log provided to DENR for each bore hole. It should be noted that r11 of the *Water Regulation* also provides information regarding samples required to be taken and shared by licensed water bore drillers. Results of any down-hole logs such as gamma and caliper should also be provided to DENR, as discussed in Sec. 2.

It is recommended that where possible, bores should be fitted with locks, to minimise risk of malicious interference with the monitoring program.

## 6. Sampling frequency

As baseline levels of some analytes are likely to vary seasonally it is important that baseline groundwater monitoring is conducted throughout the year, noting that there may be access constraints for periods during the wet season. It is suggested that sampling frequency is initially high (e.g. every 4 weeks) until the extent of natural variation is determined at the **Control monitoring bore array** shown in Figure 2, and statistically robust confidence intervals for the suite of analytes to be measured at that site and within the aquifer zone(s) of interest are established. The Report requires quarterly sampling for parameters other than E.C. for at least three years.

DENR considers that in this preliminary stage of exploration, and to meet the intent of the Report, a **Control monitoring bore array** should be established in time to allow at least six months of sampling prior to the drilling of the gas well, and that sampling should encompass the likely major extent of natural variation between late dry season and late wet season periods.

The **Impact monitoring bore array** must be installed and sampled prior to stimulating the well, noting that more than one pre-impact sample period is desirable.

## 7. Sampling methodology

Samples should generally be taken in accordance with protocols detailed in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality field sampling program ([www.waterquality.gov.au/anz-guidelines/monitoring/field-sampling-program](http://www.waterquality.gov.au/anz-guidelines/monitoring/field-sampling-program)). It is expected that sampling protocols would be detailed in the relevant Environment Management Plan (EMP) and made available to DENR for review.

The EMP must include water sampling procedures including the following components:

1. Water sampling must be undertaken by suitably qualified and trained personnel
2. Prior to sampling a water bore, wherever practicable, the volume of stagnant water within the bore casing must be calculated. Water quality samples must only be collected after:
  - a) three times the volume of stagnant water in the bore casing and the discharge piping (including a sufficient additional volume to account for any error in volume calculations) have been discharged; and
  - b) when the field water quality parameters (e.g. E.C.) have stabilised, indicating the bore is producing formation water.
3. Water quality samples must have a unique identification number that can be cross-referenced to the monitoring location and time of sampling.



**Preliminary Guideline:**  
**Groundwater Monitoring Bores for Exploration Petroleum Wells in the Beetaloo Sub-Basin**

4. Sample preservation measures are to be documented and comply with analytical laboratory requirements and relevant standards (e.g. AS/NZS 5667.1:1998).
5. Sample integrity must be maintained through the use of chain of custody procedures and documentation in accordance with section 3.7 of *Monitoring and Sampling Manual 2009 — Environmental Protection (Water) Policy 2009 (Department of Environment and Heritage Protection, 2013)*.
6. Sample analysis should be undertaken by a laboratory that is NATA approved for that analysis.

A survey benchmark relative to Australian Height Datum (AHD) should be established at each well pad monitoring bore, accurate to  $\pm 10$  cm, to accurately determine depth to water table during each sampling event.

The Analytical Suite to be assessed is listed below in Table 2. A review of the suite of analytes to be tested may be requested by the seline has been established for the monitoring bores.

Analytes of particular interest include **Total Dissolved Solids, Chloride, and Electrical Conductivity** (E.C.) as a proxy, because drilling fluids, hydraulic fracturing fluids, well suspension fluids and produced formation fluids may have orders of magnitude (100s~1000s) higher concentrations of Chloride than background values in potable waters. In addition, Strontium and Barium are typically elevated in produced water from unconventional shale gas reservoirs and serve among others as additional useful tracers. Dissolved methane is important to monitor as a baseline and over the longer term.

Groundwater pressure monitoring on a continuous basis also provides an indicator of well-integrity failure, particularly during the well-stimulation phase when the differential pressure between the aquifer and well annulus is extremely high, and thus a breach of well-integrity would be instantaneously detected. The use of this parameter as a useful reactive monitoring tool will be examined with industry during this exploration phase.

Table 2 – Required analytes

General	Anions	Cations and Metals		Petroleum
pH	<b>Chloride</b>	Calcium	Arsenic	TRH
<b>Electrical conductivity*</b>	Fluoride	Chromium	<b>Barium</b>	PAH Suite
<b>Total Dissolved Solids</b>	Sulphate	Copper	Boron	BTEX
Total Suspended Solids	Nitrate	Iron	Cadmium	Diss. Methane
Alkalinity	Nitrite	Lead	Lithium	Diss. Ethane
Gross Alpha		Magnesium	Selenium	Diss. Propane
Gross Beta		Manganese	Silica	
Water level**		Mercury	<b>Strontium</b>	
Groundwater pressure***		Potassium	Sodium	
		Silver	Zinc	

\*Recommendation 7.11 requires that electrical conductivity (E.C.) should be measured in real-time as an indicator providing 'early warning' of contamination, with the results telemetered from the site to the regulator and made available to the public. It is recognised by DENR that this may be difficult to implement in the first stages of exploration, but proponents should provide a plan and timetable to meet this requirement, preferable before hydraulic fracturing occurs.

\*\*A survey benchmark relative to Australian Height Datum (AHD) should be established at each well pad monitoring bore, accurate to  $\pm 10$  cm or better, to accurately determine water table elevation.

\*\*\*This indicator has been suggested by industry and collection of this data is encouraged in order to test validity and applicability.

## **8. Data Management**

Laboratory reports should be provided to the regulator as soon as practicable after each sampling occasion. Sampling, chain of custody and results data should also be provided in ESdat format (or another format if previously agreed with the regulator).

Further detail regarding reporting and publication mechanisms will be developed in consultation with industry, including appropriate units, file formats and data transfer protocols. This will encompass the detailed recommendations of the Report such as real time data transfer, data portals and public release of data.

**Appendix D Weed Management Plan**



# Weed Management Plan

NT-2050-15-MP-0016

## BEETALOO BASIN EXPLORATION PROJECT Weed Management Plan

### Review record

Rev	Date	Reason for issue	Author	Reviewer	Approver
0	05/10/2018	Issue for release	A Court	M Kernke	M Hanson
1	29/03/2019	Issue for release	A Court	M Kernke	M Hanson
2	20/05/2019	Minor Update	A Court	M Kernke	M Hanson

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## 1. Introduction

### 1.1 Objectives of the WMP

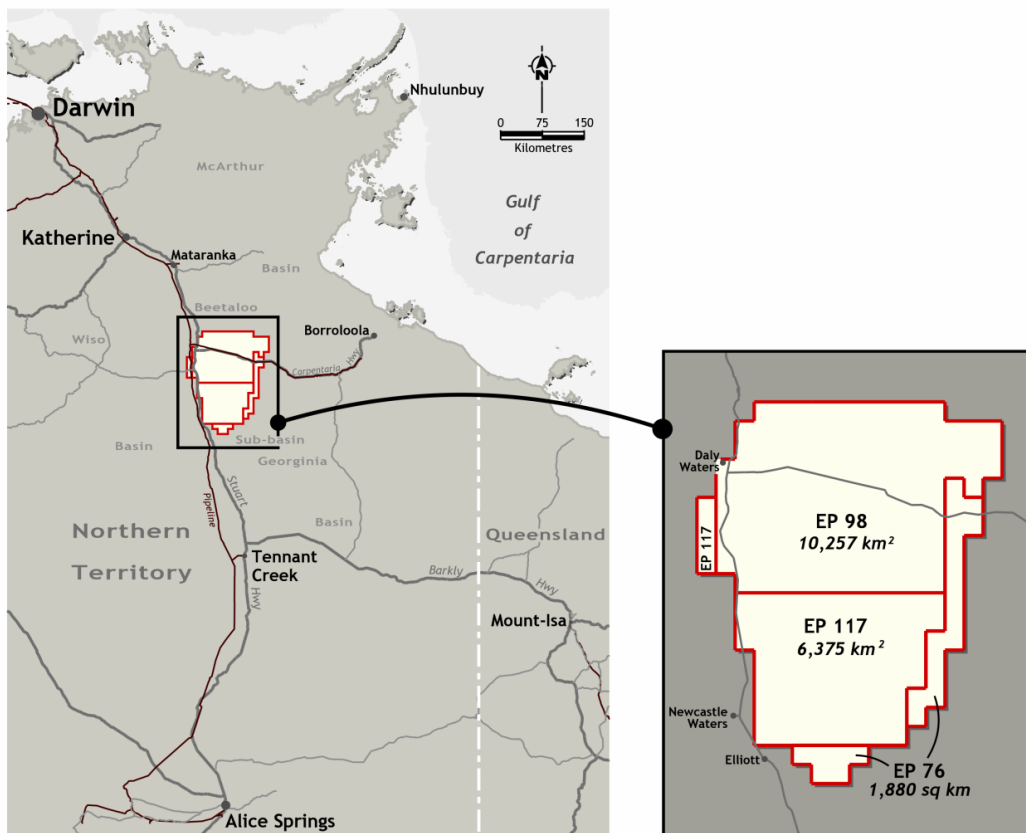
This WMP has been developed to ensure that the risk of weed introduction and spread, resulting from activities associated with Origin Exploration activities are mitigated to protect the economic, community, industry and environmental interests of the Territory.

The plan provides an overview of:

- The project context (Section 2)
- Legal requirements in relation to weed management (Section 3)
- The appointment of a Dedicated Weed Officer (Section 4)
- Identified risks and proposed mitigation measures and management objectives (Section 5 and 6)
- The weed species that are considered likely or known to occur within the Permit Area (Section 6 and 7)
- The Annual Action Plan for those species that are known to occur with the Permit Area (Section 8)
- Control options for species known to occur within the Permit Area (Section 8).
- The monitoring, notification, recording and reporting requirements for the WMP (Sections 9 – 12).

This plan is supported by Appendices that provide guidance on how to identify weed species in the field and collect the necessary data to support the monitoring and reporting requirements of this WMP.

The location of the proposed exploration activities are shown on Figure 1.



**Figure 1 Location of Origin Permit Area**

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## 1.2 Intent of the WMP

Weed control is considered to be a significant land management issue in the Northern Territory. This Weed Management Plan (WMP) forms a core component of Origin's overarching environmental management strategy and supports the various project Environmental Management Plan (EMP's).

The movement of rigs, vehicles, machinery and other materials to, from and within the exploration permit area may result in weeds being moved around the pastoral lease, into the lease from surrounding areas or interstate, depending on where the vehicles and materials are sourced from or returned to.

The focus of this WMP is therefore to ensure that infestations are eradicated, or at the very least that existing weed infestations are controlled such that no further weed species colonise the permit area as a result of Origin's activities.

This document is based upon the Weed Management Planning Guide - Onshore Shale Gas Development Projects produced by the Department of Environment and Natural Resources (2018).

## 2. Project Context

This plan covers all civil, drilling, stimulating, rehabilitation and routine maintenance/monitoring activities undertaken by Origin within permit EP76, EP98 and EP117 as detailed in Table 1. The proposed activities for the 2019/2020 program are highlighted within the table.

**Table 1 Coordinates of centroid of proposed exploration lease areas**

Exploration Permit	Lease Name	Zone*	Easting	Northing
EP98	Velkerri 98 E1-	53	415515	8180683
EP98	Velkerri 98 N1	53	392292	8189891
EP98	Kyalla 98 W1	53	364955	8177458
EP76	Velkerri 76 S1	53	424362	8113273
EP76	Velkerri 76 S2	53	435488	8136321
EP117	Kyalla 117 N2	53	356175	8137500
EP117	Stuart Highway Intersection	53	332371	8135170
EP117	Velkerri 117 E1	53	428861	8120782
EP117	Kyalla 117 W1	53	368079	8106696

*Grey shading are planned sites for 2019/200*

*\* Universal Transverse Mercator (UTM) geographic coordinate system is Geocentric Datum of Australia (GDA) 94.*

The primary activities subject to this WMP are:

- Access track construction, use and maintenance
- Exploration lease pad construction, use and maintenance
- Gravel pit construction and maintenance
- Drilling, stimulating, completing and maintaining petroleum exploration wells
- Routine access, maintenance and monitoring of all exploration areas subject to this plan.

## 3. Legal Requirements

The following presents the relevant legislation and statutory obligations for the project.

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## 3.1 Northern Territory Petroleum (Environment) Regulations

### ***Petroleum Act 2016, Petroleum (Environment) Regulations 2016 and Code of Practice for Petroleum Activities with in the Northern Territory***

The *Petroleum Act 2016* provides legal framework within which persons are encouraged to undertake effective exploration for petroleum and to develop petroleum production so that the optimum value of the resource is returned to the Territory. It regulates the exploration for, and production of petroleum, including environmental protection measures which should be employed during exploration and production activities, including protection of parks and reserves and rehabilitation.

In addition, the Act is supported by the *Petroleum (Environment) Regulations 2016*.

The *Petroleum (Environment) Regulations 2016* requires that regulated activities are carried out in a manner consistent with the principles of ecologically sustainable development, and by which the environmental impacts and environmental risks of the activities are identified and reduced to an acceptable level.

The *Code of Practice for Petroleum Activities in the Northern Territory* is a mandatory code of practice for the petroleum industry to ensure that petroleum activities in the Northern Territory are managed according to minimum acceptable standards to ensure that risks to the environment can be managed to a level that is as low as reasonably practical (ALARP) and acceptable.

Under these regulations Origin is required to submit an EMP prior to any petroleum exploration or production activity.

EMP's must include:

- potential environmental risks or impacts (in this instance relating to the introduction and spread of weeds);
- appropriate environmental outcomes, environmental performance standards and measurement criteria;
- appropriate implementation strategy and monitoring, recording and reporting arrangements; and
- demonstrate that there has been an appropriate level of engagement with directly affected stakeholders in developing the plan.

This WMP is designed to support and implement the requirements of Origins Project Specific Environmental Management Plans.

## 3.2 Northern Territory Weeds Management Act

The aim of the *Weeds Management Act (2013)* is 'to protect the Territory's economy, community, industry and environment from the adverse impact of weeds'.

The purpose of the Act, as defined in section 3, is:

- To prevent the spread of weeds in, into and out of the Territory and to ensure that the management of weeds is an integral component of land management in accordance with the Northern Territory Weeds Management Strategy 1996 – 2005 or any other strategy adopted to control weeds in the Territory.
- To ensure there is community consultation in the creation of weed management plans.
- To ensure that there is community responsibility in implementing weed management plans.

The Act identifies declared weeds (those which must be controlled) and provides a framework for weed management. It includes the following weed declaration classes:

- Class A – to be eradicated
- Class B – growth and spread to be controlled
- Class C\* – Not to be introduced into the Northern Territory
- \* All Class A and B weeds are also Class C.

The Act enables the relevant Minister to approve statutory weed management plans. Management obligations in these plans must be adhered to.

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Currently there are statutory management plans for 10 high priority weed species in the Northern Territory.

The WMP must address weeds in accordance with their declaration status and the statutory requirements of any relevant weed management plans.

### 3.3 Regional Weed Management Plans

Regional Weed Management Plans (RWMP) have been developed for areas of the NT, with the Barkly and the Katherine RWMP overlapping Origin's Beetaloo exploration tenure. The aim of these regional plans is to assist in prioritising weed management by:

- identifying the region's priority weeds and associated pathways of spread to inform management priorities
- identifying landscapes that may need prioritised protection from weed impacts like river corridors or sacred Aboriginal sites
- containing information on alert weeds that are not yet found in the region, but could become major issues if they establish

### 3.4 Commonwealth Environment Protection Biodiversity Conservation Act

The objectives of the *Environment Protection and Biodiversity Conservation (EPBC) Act* (1999) are, among other things:

- provide for the protection of the environment, especially those aspects of the environment that are matters of national environmental significance; and
- promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources; and
- promote the conservation of biodiversity; and
- promote a co-operative approach to the protection and management of the environment involving governments, the community, land-holders and indigenous peoples; and
- assist in the co-operative implementation of Australia's international environmental responsibilities.

The *EPBC Act* provides for the identification and listing of key threatening processes. A threatening process is defined as a key threatening process if it threatens or may threaten the survival, abundance or evolutionary development of a native species or ecological community. Key threatening processes include invasive species, such as weeds, which have a major impact on Australia's environment, threatening our unique biodiversity and reducing overall species abundance and diversity (DOTEE 2018).

## 4. Dedicated Weed Officer

As per recommendation 8.3 of the Scientific Inquiry into Hydraulic Fracturing Stimulation there must be a dedicated Weed Officer for each gas field.

The Weed Officer must have relevant skills and experience and availability to successfully manage weed related issues for the project, including:

- Knowledge of the biology/ecology of local weeds.
- Knowledge of relevant weed management frameworks including Northern Territory legislation and plans, the *EPBC Act*.
- Understanding of existing weed management arrangements being undertaken by landholders.

The Weed Officer is responsible and accountable for delivery of all weed related requirements of the project in accordance with the WMP and the overarching Environmental Management Plan, including:

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- Planning and execution of weed monitoring requirements, including baseline weed assessments and ongoing monitoring both during periods of gas related activities as well as during the target identification period of February to May.
- Facilitate training all workers (including contractors) in weed management requirements, with support from the Northern Territory Government Regional Weed Officer - Onshore Shale Gas Development.
- Oversight of implementation of weed control mechanisms including but not limited to wash-downs and proactive weed control programs.
- Ensuring all reporting requirements are met.
- Act as the designated point of contact for and rapidly responding to any weed related complaints and incidents in accordance with the pre-determined strategies in this WMP and additional strategies as required developed in consultation with the Regional Weed Officer - Onshore Shale Gas Development and affected landholders.
- Review and update of WMP's to remain effective in communication with relevant landholders and Regional Weed Officer - Onshore Shale Gas Development in consideration of monitoring results and emerging weed issues for both gas and pastoral operations.

Origin has appointed **Robert Wear, Construction Superintendent** as the dedicated Weed Officer of the Beetaloo Exploration Activities.

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## 5. Weed Species Information

Weed surveys completed in August 2018 indicate the abundance of weeds within the proposed project area is low. *Hyptis suaveolens* (Hyptis), was identified along the access track to the proposed Velkerri 98-E1-1 site, whilst Gamba Grass (*Andropogon gayanus*) is also known to be in the broader region and is used by some Pastoralists in the region for wet season pasture. The pastoral properties using Gamba would be required to control the growth and spread to neighbouring areas (NTG, 2000).

Previous surveys within the permit area completed in 2014, 2015 and 2016 also confirmed the presence of Hyptis in the vicinity of the Carpentaria Highway near Velkerri 98 N1-2 (previously known as Amungee NW-1) site. *Parkinsonia aculeata* (Parkinsonia) and *Calotropis procera* (Rubber Bush) have been previously identified along/in close proximity to the Beetaloo access track. Parkinsonia is considered a Weed of National Significance (WoNS), which are weed species that are the focus of national management programs for the purpose of restricting their spread and/or eradicating them from parts of Australia. These species are specifically presented in Table 2 and Section 8.

Figure 2 illustrates the weeds species confirmed in the region during field surveys, along with other weed species that are known to occur or likely to occur within the wider exploration Permit Areas. This information is based on:

- Origin exploration program weed survey data (2014-2018 results)
- Mapping data provided by the Weed Management Branch, DENR.
- Guidelines for the *Management of the Weeds of Beetaloo 2018* (DLRM et al 2018).
- Barkly and Katherine Regional Weed Management Plans (RWMP)
- Department of the Environment and Energy (DOEE) EPBC Act Protected Matters Report database.

Table 3 has been separated into priority weeds, RWMP alert species and other species previously identified in the area. Priority weed species are considered higher risk of being introduced or spread through the following criteria:

- Weed species that has been confirmed in the area within the relevant RWMP or through field surveys.
- Weed species listed in a RWMP that is in close proximity to Origin tenure.
- Weed species that are at risk of introduction through the use of machinery sourced from other regions in the NT or from other states.

Alert weed species are identified under the Katherine and Barkley RWMP. These species are not yet naturalised in the region, but have the potential to have a high level of impact to the region should it become established. The likelihood of the species naturalising and spreading in the region is perceived to be high (Department of Land Resource Management 2015).

It is noted that *Parthenium hysterophorus* is a major problem in rangelands and cropping areas of Queensland and is estimated to cost farmers and graziers more than \$22 million a year in reduced production and increased management costs. Vehicle, machinery and material movements from Queensland into the project area present a risk of spread of *Parthenium* if not managed correctly (Department of Primary Industry and Resources 2016).

Additional mapped locations of weeds within the Barkly and Katherine RWMP are provided in Figure 3 and Figure 4.

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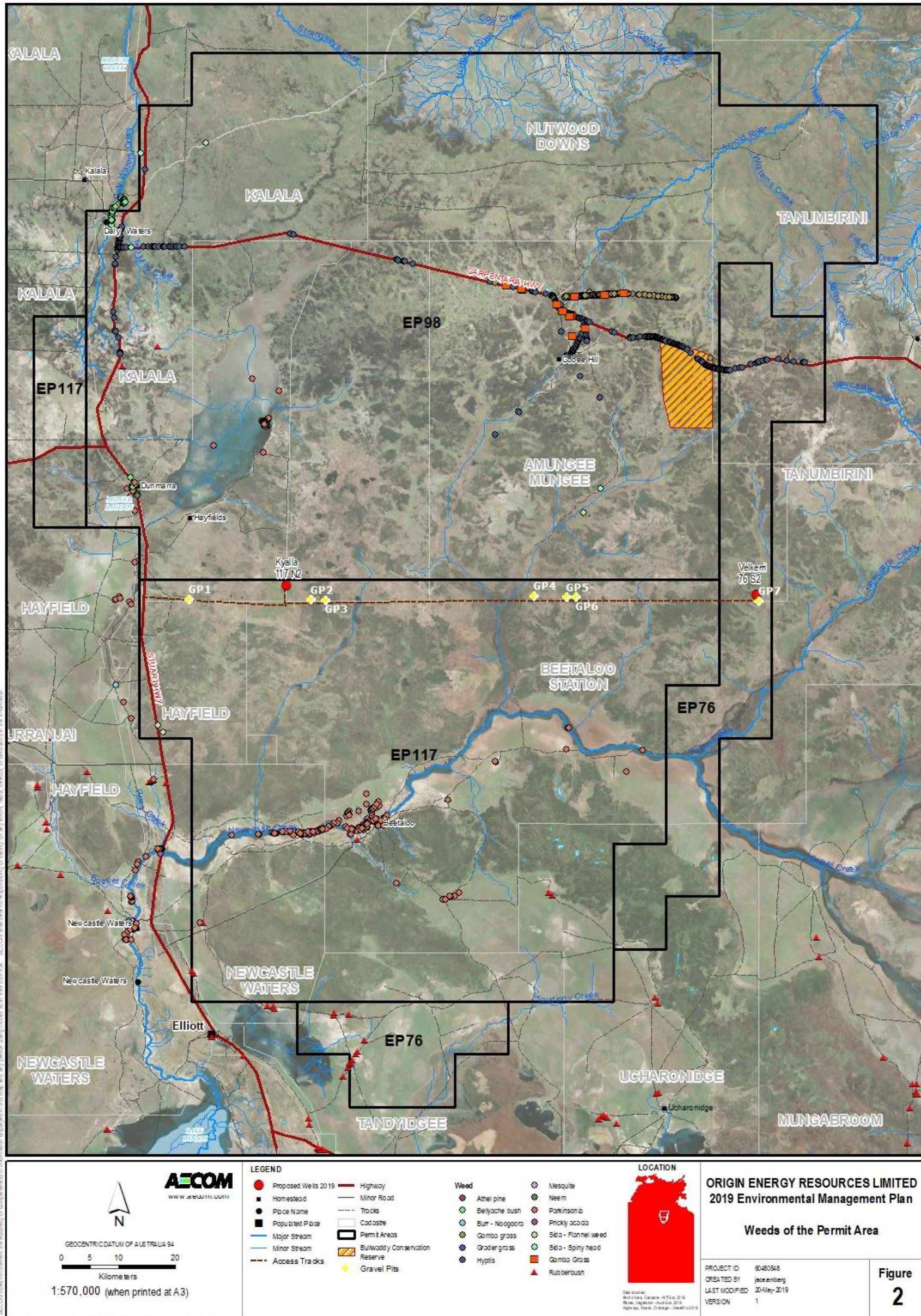


Figure 2 Location of Weeds Species in Permit Areas

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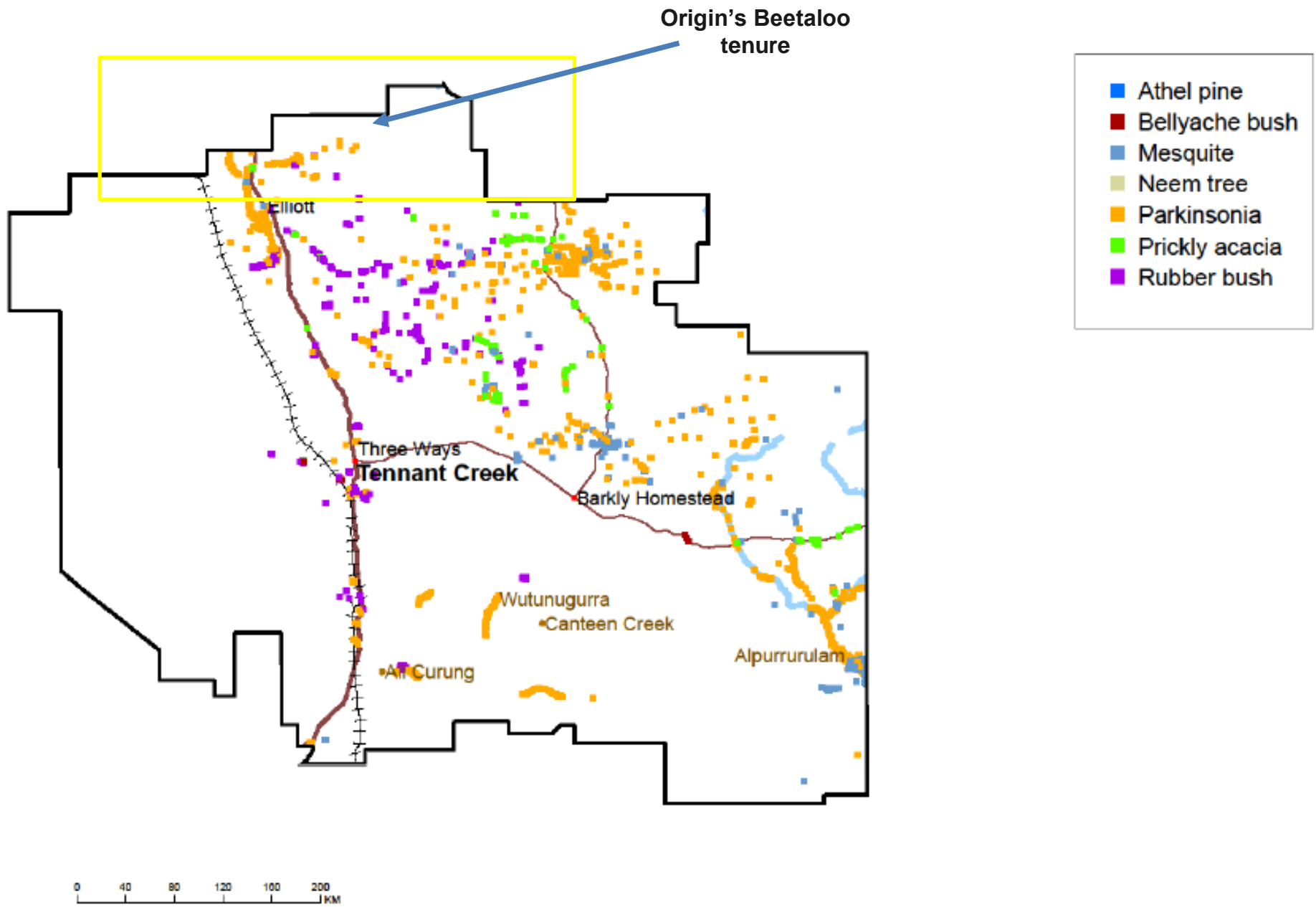


Figure 3 Barkly RWMP mapped priority weed locations

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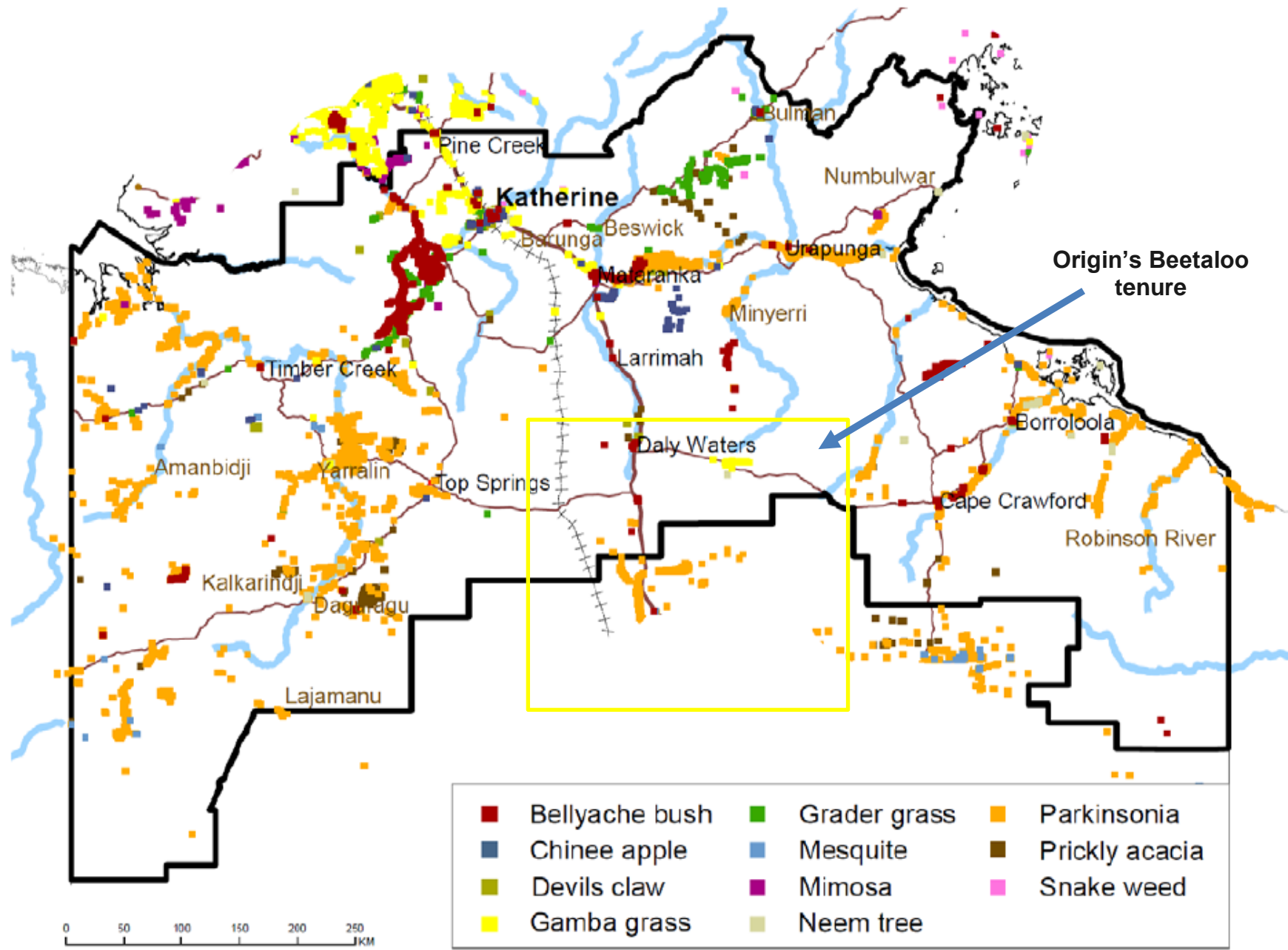


Figure 4 Katherine RWMP mapped priority weeds

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**Table 2 NT listed weeds known of likely to occur within the Permit Area**

Scientific Name	Common Name	Status	Data Source
<b>Priority Weed Species</b>			
<i>Acacia nilotica</i>	Prickly Acacia	Class A, WoNS	Mapped in the exploration lease within the Katherine RWMP
<i>Andropogon gayanus</i>	Gamba Grass	Class A WoNS	Confirmed within exploration lease. High potential introduction through sourcing of equipment from Katherine and Darwin area.
<i>Calotropis procera</i>	Rubber Bush	Class B and C	Mapped in the exploration lease within the Barkly RWMP
<i>Hyptis suaveolens</i>	Hyptis	Class B and C	Confirmed within exploration lease during previous weed Origin surveys
<i>Jatropha gossypifolia</i>	Bellyache Bush	Class A, WoNS	Mapped in the exploration lease within the Katherine RWMP. Potential introduction through sourcing of equipment from Katherine area.
<i>Parkinsonia aculeata</i>	Parkinsonia	Class B and C, WONS	Confirmed within exploration lease during previous weed Origin surveys and Mapped in the exploration lease within the Katherine RWMP. Potential introduction through sourcing of equipment from Katherine area.
<i>Prosopis pallida</i>	Mesquite	Class A and C, WONS	Mapped in the area surrounding exploration lease within the Katherine and Barkly RWMP
<i>Themeda quadrivalvis</i>	Grader Grass	Class B and C, WoNS	Confirmed within the exploration lease and mapped in the area within the Katherine RWMP. High potential introduction through sourcing of equipment from Katherine area.
<i>Parthenium hysterophorus</i>	Parthenium	Class A and Class C, WoNS	Confirmed by DENR to occur within the exploration lease. Potential introduction through equipment sourced from QLD.
<b>Alert Species under RWMP</b>			
<i>Cenchrus setaceum</i>	Fountain grass	Class B and C	Alert Species within the Barkly Region
<i>Cryptostegia grandiflora</i>	Rubber vine	Class A and C, WONS	Alert Species within the Barkly and Katherine RWMP
<i>Chromolaena odorata</i>	Siam Weed	Class C	Alert Species Katherine RWMP

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Scientific Name	Common Name	Status	Data Source
<b>Other species potentially found in region</b>			
<i>Alternanthera pungens</i>	Khaki Weed	Class B and C	DLRM databases (DLRM <i>et al</i> 2018)
<i>Azadirachta indica</i>	Neem	Class B and C	Weed Management Branch – Mapping data
<i>Cenchrus ciliaris</i>	Buffel Grass	Not declared in NT	DOTEE Protected Matters Report
<i>Cenchrus echinatus</i>	Mossman River Grass	Class B and C	DLRM databases (DLRM <i>et al</i> 2018)
<i>Datura ferox</i>	Fierce Thornapple	Class A and C	DLRM databases (DLRM <i>et al</i> 2018)
<i>Sida acuta</i>	Spinyhead sida	Class B and C	Weed Management Branch – Mapping data
<i>Sida cordifolia</i>	Flannel Weed	Class B and C	Weed Management Branch – Mapping data DLRM databases (DLRM <i>et al</i> 2018)
<i>Sida rhombifolia</i>	Paddy's Lucerne	Class B and C	DLRM databases (DLRM <i>et al</i> 2018)
<i>Xanthium occidentale</i>	Noogoora Burr	Class B and C	Weed Management Branch – Mapping data DLRM databases (DLRM <i>et al</i> 2018)

Note: Declarations under the Northern Territory Weeds *Management Act 2013*.

## 6. Weed Introduction and Spread Risks

As part of the development of the EMP for this project, Origin has undertaken a preliminary assessment of the risk of introducing or spreading weeds in the project area. This assessment and the corresponding proposed mitigation measures and management objectives are presented in Table 3 below. Due to the low abundance of weeds within the proposed project area, management controls will primarily focus on preventing the introduction of weed species through appropriate equipment sourcing cleaning and inspection.

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**Table 3 Risk of weed introduction and spread and corresponding mitigation measures**

<b>Environmental Values</b>	Maintain the integrity of significant ecosystems and agricultural productivity		
<b>Management Objectives</b>	Avoid the introduction of weeds Avoid the spread of existing weeds		
<b>Measures Criteria</b>	No introduction or spread of declared weeds resulting from Origins activities.		
<b>Activity</b>	<b>Potential Risks</b>		<b>Management Controls</b>
	<b>Introduction of new weeds</b>	<b>Spread of existing weeds</b>	
Vehicle and equipment movements	Vehicles and equipment sourced from other locations infested with weed species not found in or around Project Area	Traversing of weed infested areas with machinery	<ul style="list-style-type: none"> <li>- Code of Practice for Petroleum Activities in the Northern Territory Part A- Surface Activities.</li> <li>- Activities will adhere to the guidelines within the NT Weed Management Handbook.</li> <li>- Weed management and control measures to be implemented in alignment with existing landholder biosecurity requirements.</li> <li>- All equipment will have certified equipment wash-down completed prior to entry to the field. Wash-down would occur at Contractors depot or a commercial wash facility prior to mobilisation in a manner that prevents pollution of the surrounding environment.</li> <li>- Machinery to be preferentially sourced locally, with machinery sourced from surrounding areas or Queensland being the 2nd and 3rd preferred option respectively.</li> <li>- Weeds will be actively controlled in cleared/ hardstand areas.</li> <li>- Major equipment moves will be planned from weed-free areas to infested areas and not the other way around.</li> <li>- Ensuring all material imported to or between sites is free of weeds.</li> </ul>
Construction of access tracks and monitoring bore pads	Importing materials from areas where weeds are present and creating opportunities for weed species to colonise disturbed areas	Traversing of weed infested areas and creating opportunities for weed species to colonise disturbed areas	<ul style="list-style-type: none"> <li>- Code of Practice for Petroleum Activities in the Northern Territory Part A- Surface Activities.</li> <li>- Activities will adhere to the guidelines within the NT Weed Management Handbook.</li> <li>- Weed management and control measures to be implemented in alignment with existing landholder biosecurity requirements.</li> <li>- All equipment will have certified equipment wash-down completed prior to entry to the field.</li> <li>- Ensure field staff, contractors and machinery operators are familiar with hygiene protocols and weed identification.</li> <li>- Machinery to be preferentially sourced locally, with machinery sourced from surrounding areas</li> </ul>

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# Weed Management Plan

NT-2050-15-MP-0016

<b>Environmental Values</b>	Maintain the integrity of significant ecosystems and agricultural productivity		
<b>Management Objectives</b>	Avoid the introduction of weeds Avoid the spread of existing weeds		
<b>Measures Criteria</b>	No introduction or spread of declared weeds resulting from Origins activities.		
<b>Activity</b>	<b>Potential Risks</b>		<b>Management Controls</b>
	<b>Introduction of new weeds</b>	<b>Spread of existing weeds</b>	
			<p>or Queensland being the 2nd and 3rd preferred option respectively.</p> <ul style="list-style-type: none"> <li>- Weeds will be actively controlled in cleared/hardstand areas.</li> <li>- Stabilise disturbed areas.</li> </ul>
Drilling, stimulation and well testing	Introduction of weed species not found in or around EP area.	Traversing of weed infested areas with machinery	<ul style="list-style-type: none"> <li>- Code of Practice for Petroleum Activities in the Northern Territory Part A- Surface Activities.</li> <li>- Activities will adhere to the guidelines within the NT Weed Management Handbook.</li> <li>- Weed management and control measures to be implemented in alignment with existing landholder biosecurity requirements.</li> <li>- All equipment will have certified equipment wash-down completed prior to entry to the field. Wash-down would occur at Contractors depot or a commercial wash facility prior to mobilisation in a manner that prevents pollution of the surrounding environment.</li> <li>- Ensure field staff, contractors and machinery operators are familiar with hygiene protocols and weed identification.</li> <li>- Weeds will be actively controlled in cleared/hardstand areas.</li> <li>- Major equipment moves will be planned from weed-free areas to infested areas and not the other way around.</li> <li>- Drilling and stimulation equipment will be restricted to cleared lease areas.</li> <li>- Ensuring all material imported to or between sites is free of weeds.</li> </ul>
Operational/site management	Personnel unable to identify weeds or unaware of weed species present in areas where machinery and equipment is sourced from	Existing weed distribution not known due to: insufficient survey effort, surveys conducted at wrong time of year, surveyors not familiar with / unable to identify	<ul style="list-style-type: none"> <li>- Code of Practice for Petroleum Activities in the Northern Territory Part A- Surface Activities.</li> <li>- Staff members responsible for preventing, identifying and managing weeds to be appropriately trained.</li> <li>- Weed desktop and field-based surveys to be provided to identify existing weed areas.</li> <li>- Pre-and post wet (February to May) inspections and periodic audits will be conducted to identify and report weed outbreaks.</li> </ul>

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# Weed Management Plan

NT-2050-15-MP-0016

<b>Environmental Values</b>	Maintain the integrity of significant ecosystems and agricultural productivity		
<b>Management Objectives</b>	Avoid the introduction of weeds Avoid the spread of existing weeds		
<b>Measures Criteria</b>	No introduction or spread of declared weeds resulting from Origins activities.		
Activity	Potential Risks		Management Controls
	Introduction of new weeds	Spread of existing weeds	
		declared weed species	
	Insufficient management control to prevent the introduction of weeds	Insufficient management control to prevent the spread of weeds	<ul style="list-style-type: none"> <li>- Staff members responsible for preventing, identifying and managing weeds to be appropriately trained.</li> <li>- Ensure field staff, contractors and machinery operators are familiar with hygiene protocols and weed identification (Weed identification posters and the NTG Weed Deck will be made available)</li> <li>- Weeds will be actively controlled in cleared/ hardstand areas.</li> <li>- Weed management and control measures to be implemented in alignment with existing landholder biosecurity requirements.</li> <li>- New activities will be planned to address prevention of weed or non-indigenous plant spread.</li> </ul>

## 7. Statutory Weed Management Plans

No statutory weeds have been identified during surveys of the Project Area, however the following plans apply to species that have been found/ could be potential found in the broader region.:

- Weed Management Plan for Athel pine (*Tamarix aphylla*)
- Weed Management Plan for Mesquite (*Prosopis* spp.)
- Weed Management Plan for Prickly Acacia (*Acacia nilotica*)
- Weed Management Plan for Bellyache Bush (*Jatropha gossypifolia*)
- Weed Management Plan for Neem (*Azadirachta indica*)
- Weed Management Plan for Gamba Grass (*Andropogon gayanus*)
- Weed Management Plan for Grader Grass (*Themeda quadrivalvis*).

The weed management plans detail the legislated obligations of all land owners, land managers and land users in the Northern Territory to eradicate or manage and avoid further spread of the weed species. Conducting land management practices in accordance with the weed management plans will secure compliance with the requirements of the Act (Department of Land Resource Management 2015).

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# Weed Management Plan

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## 8. Annual Action Plan

An action plan for each of the weed species identified in the Project Area is presented in Table 4. Treatment options as contained in the Northern Territory Weed Management Handbook are presented in Section 8.1 to Section 8.3.

This section will be updated if new weed species are discovered over the life of the program to ensure that statutory requirements with relation to declaration status and relevant weed management plans are addressed (refer to Section 7)

As part of the 2019 Annual Weed Management Action Plan, Origin also commits to undertaking finer detailed weed mapping of all permit area, lease pads, access tracks and gravel pits, as well as any other areas disturbed as part activity.

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**Table 4 Annual Weed Management Action Plan**

Management objective	<ul style="list-style-type: none"> <li>- Avoid the introduction of weeds</li> <li>- Avoid the spread of existing weeds</li> </ul>			
Weed species	Survey time/s	Treatment time/s	Control options	Where located
Hyptis <i>Hyptis suaveolens</i>	6 monthly- pre-and post wet season	<ul style="list-style-type: none"> <li>- Preferred Dec – Mar</li> <li>- Also Nov and April</li> </ul>	Refer to section 7.1.	Beetaloo access track Access track to Velkerri 98-E1-1 site
Parkinsonia <i>Parkinsonia aculeata</i>	6 monthly- pre-and post wet season	<ul style="list-style-type: none"> <li>- Preferred Mar – May</li> <li>- Also all year round</li> </ul>	Refer to section 7.2.	Beetaloo access track
Rubber Bush <i>Calotropis procera</i>	6 monthly- pre-and post wet season	<ul style="list-style-type: none"> <li>- Preferred October – March</li> <li>- April - July</li> </ul>	Refer to section 7.3.	Close proximity to the Beetaloo access track

## 8.1 Hyptis (*Hyptis suaveolens*) treatment options

Table 5 includes herbicide and non-chemical treatment options for Hyptis (*Hyptis suaveolens*) (Northern Territory Government 2015).

**Table 5 Hyptis (*Hyptis suaveolens*) treatment options**

Weed Species	Hyptis ( <i>Hyptis suaveolens</i> )		
Control Methods	Chemical and concentration	Rates	Weed growth stage, method and comments
Herbicides	<b>2, 4-D amine 625 g/L</b> Various trade names	320 mL / 100 L	<b>Seedling or adult (individuals or infestation):</b> Foliar spray - apply when actively growing.
	<b>Glyphosate 360 g/L</b> Various trade names and formulations	15 mL / 1 L	<b>Seedling or adult (individuals or infestation):</b> Foliar spray - apply when actively growing.
Non-chemical applications	- Manually remove all plant material; slash to encourage competition from desirable species.		

Source: Northern Territory Weed Management Handbook (Northern Territory Government 2015).

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## 8.2 Parkinsonia (*Parkinsonia aculeata*) treatment options

Table 6 includes herbicide and non-chemical treatment options for Parkinsonia (*Parkinsonia aculeata*) (Northern Territory Government 2015).

**Table 6 Parkinsonia (*Parkinsonia aculeata*) treatment options**

Weed Species	Parkinsonia ( <i>Parkinsonia aculeata</i> )		
Control Methods	Chemical and concentration	Rate	Weed growth stage, method and comments
Herbicides	<b>Aminopyralid 8 g/L + Triclopyr 300 g/L + Picloram 100 g/L</b> Grazon™ Extra	350 mL / 100 L or 3 L / ha	<b>Seedling (individuals and infestation)</b> Foliar spray – avoid spraying if plants are stressed or bearing pods – Uptake Spraying Oil required Foliar spray – plants up to 2 m or 2 years old - Uptake Spraying Oil required.
	<b>Triclopyr 240 g/L + Picloram 120 g/L</b> Access™	1 L / 60 L (diesel) 1 L / 60 L (diesel)	<b>Seedling or adult (individuals or infestation)</b> Basal bark < 5 cm stem diameter Cut stump > 5 cm stem diameter
	<b>Tebuthiuron 200 g/kg</b>	1.5 g / m2	<b>Seedling or adult (individuals or infestation)</b> Granulated herbicide - ground applied Do not use within 30 m of desirable trees or apply to continuous area > 0.5 ha. Do not use if fire is eminent. Apply when there is soil moisture or prior to rain.
Non-chemical applications	<ul style="list-style-type: none"> <li>- Blade-ploughing, stick-raking, bulldozing and chaining can be effective if the root layer is removed from the soil.</li> <li>- Cultivation of pasture or native vegetation after mechanical control will help to prevent re-sprouting and seedling establishment.</li> <li>- Fire destroys seed in the soil surface and can be used as a follow-up to remove seedlings after other control efforts.</li> <li>- Fire may also be used to manage mature trees. Hand grubbing for single plants or small outbreaks, ensure removal of the root system.</li> <li>- Biocontrol options are available with Uu establishing slowly in some areas.</li> </ul>		

Source: Northern Territory Weed Management Handbook (Northern Territory Government 2015).

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## 8.3 Rubber bush (*Calotropis procera*) treatment options

Table 7 includes herbicide and non-chemical treatment options for Rubber bush (*Calotropis procera*) (Northern Territory Government 2015).

**Table 7 Rubber bush (*Calotropis procera*) treatment options**

Weed Species	Rubber bush ( <i>Calotropis procera</i> )		
Control Methods	Chemical and concentration	Rate	Weed growth stage, method and comments
Herbicides	<b>Triclopyr 300 g/L + Picloram 100 g/L</b> <b>Conqueror®</b>	750 mL / 100 L (water)	<b>Seedling (individuals or infestation):</b> Foliar spray. Check label for recommended adjuvant product. More effective on plants <2m as thorough coverage on all leaves is required
	<b>+ Aminopyralid 8 g/L</b> Grazon™ Extra	500-750mL / 100 L (water)	
	<b>Triclopyr 240 g/L + Picloram 120 g/L</b> Access™	1 L / 60 L (diesel) 1 L / 10 L (diesel) 1 L / 60 L (diesel)	<b>Adult (individuals and infestation):</b> Basal bark < 5cm stem diameter. Spray all stems. Spray to point of runoff. Thin Line up to 5cm stem diameter. Cut stump > 5cm stem diameter.
	<b>Tebuthiuron (200g/kg)</b> Graslan Pending registration. Please check with Weed Management Branch for status confirmation.	1.5-2g/m2	<b>Seedling or adult:</b> Application to black clay soils in conjunction with seasonal rainfall. Spread granules according to density of the infestation.
	<b>Fluroxypyr (333g/L)</b> Starane™ Advanced	3 L / 100 L (diesel)	<b>Adult:</b> Cut stump method for plants up to 10cm diameter and 3m high.
Non-chemical applications	<ul style="list-style-type: none"> <li>- This plant is difficult to eradicate as the deep roots survive almost any treatment.</li> <li>- Maintenance of a dense pasture sward will assist in preventing invasion.</li> </ul>		

Source: Northern Territory Weed Management Handbook (Northern Territory Government 2015).

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## 9. Notification Procedure

The Regional Weed Officer – Onshore Shale Oil Gas Development at the Weed Management Branch of the DENR should be notified within 48 hours of the discovery of a new weed species in the Project Area.

Initial notification may be verbal, with follow-up written notification provided within seven working days. The notification should include a preliminary species identification and location information. The Regional Weed Officer will advise what further action is required.

It is noted that some species spread rapidly so immediate action may be required to control spread. For example, as stated above *Parthenium* (*Parthenium hysterophorus*) is a Class A (to be eradicated) and Class C (not to be introduced) weed in the Northern Territory as well as being classified as a Weed of National Significance. Early detection is crucial in not allowing this species to spread in the Northern Territory (Department of Primary Industry and Resources 2016).

In addition, it is noted that under the *Weeds Management Act* that:

*'The owner and occupier of land must... within 14 days after becoming aware of a declared weed that has not previously been, or known to have been, present on the land, notify an officer of the presence of the declared weed'.*

All weed outbreak incidents will be reported in Origin's OCIS and corrective action initiated.

## 10. Recording

Records of weed inspections will be maintained by Origin.

Data on weed distribution will be maintained within Origin's GIS and provided to the Weeds Officer at DENR as part of the annual report on performance against the Weed Management Plan, or as requested.

Data will be collected as per the requirements of the Northern Territory Weed Data Collection Manual - Section One Technical Data Description (Weed Management Branch, 2015).

Data will be recorded using the guidelines provided in Appendix A using the data sheet provided in Appendix B (Weed Management Branch, 2015).

The Northern Territory Weed ID Deck (Northern Territory Government 2017) will be referenced to assist with identification of species that have been identified as likely or know to occur in the Permit Area.

Field data will be submitted directly to the Weed Management Branch in a shapefile format or as an Excel spreadsheet, including incidental identification of weeds and following completion of field surveys.

## 11. Reporting

All weed outbreak incidents will be reported in Origin's OCIS and corrective action initiated.

A report on the performance against this Weed Management Plan will be submitted to DENR on an annual basis.

At a minimum, this should include:

- a) Details of activities implemented to address weed spread and introduction risks (e.g. vehicle wash down/blow down locations, examples of track construction from working from weed free areas into weed infested areas to reduce spread).
- b) Details of survey and monitoring events, including dates, personnel, maps and track data.
- c) Submission of all weed data collected.
- d) Overview of weed control events and success rates (weed control should be captured in detail through the data collection process and submitted as a component of (a)).

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## 12. References

- Department of the Environment and Energy. 2018. *Key threatening processes under the EPBC Act*. <http://www.environment.gov.au/biodiversity/threatened/key-threatening-processes> accessed 14 September 2018.
- Department of Land Resource Management. 2015. *Barkly Regional Weed Management Plan 2015 - 2020*.
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- Department of Primary Industry and Resources. 2016. *Parthenium found in the NT*. <https://dpiir.nt.gov.au/news/2016/december/parthenium-found-in-the-nt> accessed 14 September 2018.
- Northern Territory Government. 2000. *Information Sheet Gamba Grass*. [http://www.drytropics.org.au/weeds\\_gamba\\_control.htm](http://www.drytropics.org.au/weeds_gamba_control.htm) accessed 29 March 2019.
- Northern Territory Government. 2015. *NT Weed Management Handbook*.
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- Northern Territory Government. 2018. *A – Z List of Weeds in the Northern Territory*. <https://nt.gov.au/environment/weeds/weeds-in-the-nt/A-Z-list-of-weeds-in-the-NT> accessed 13 September 2018.
- Scientific Inquiry into Hydraulic Fracturing in the Northern Territory. 2018. *Scientific Inquiry into Hydraulic Fracturing in the Northern Territory – Final Report*.
- Weed Management Branch, Northern Territory Government. 2015. *Northern Territory Weed Data Collection Manual - Section One Technical Data Description*.

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## Appendix A Weed Data Collection Methodology

### Field data collection for weed infestations

The following is a guide to efficiently evaluating and recording a weed site in the field.

Each record must identify the person or organisation taking the record, as well as the details explained below.

#### How to record weed area as a point record

##### 1. Record the species.

When a weed is sighted, move to the area and confirm identification of the weed. If you cannot positively identify the weed record it as “Unknown weed” and take a sample or photograph, do not try to guess. If more than one weed species is present then repeat the process with separate records for each species.

##### 2. Assess the size of the weed patch.

Look across the area of weeds to the furthest weed plant and decide the diameter. Decide if the area is best fits in a circle of either 20, 50 or 100 metres. If it is a single plant or small patch you would choose 20 metres. The size 100 metres extends about as far as you can see on the ground, if the weeds extend out of sight you will need to make another point further on. You may place overlapping circle areas to reflect different densities.

##### 3. Assess the density of weeds within the circle.

Decide how much of the area is covered by weeds. Assign a score from 2 to 5 based on the percentage table below. It will be useful (if possible) to move into the centre of the weed circle. Consider the whole circle size chosen in step 2 deciding on the density score. Area covered should be determined by a ‘projected canopy’ method.

#### Density categories

1 = Absent, no weeds of this species in this area.

2 = < 1%, Very few, not many weeds eg: single plant, perhaps with seedlings.

3 = 1 -10%, More than one or two isolated plants but not a lot eg: a few small plants.

4 = 11-50%, A lot, up to half the area covered eg: a tree, dense patches of weeds.

5 = > 50%, Dominant cover is weed, more than half covered eg: thickets, monocultures.

##### 4. Record the location.

Take the GPS location (ideally) from the centre of the circle. If weed seeds may be spread or it is difficult to access the centre it is acceptable to take the reading from the location as close to the centre as practical.

##### 5. Record the treatment.

Record the method you apply a treatment to the weeds, or record ‘No Treatment’.

Choose from the list of treatment methods

i.e: No treatment, Unknown, Treated, Foliar spray etc.

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## How to record weed area as a line (polyline) record

### 1. Record the species.

When a weed is sighted, move to the area and confirm identification of the weed. If you cannot positively identify the weed record it as "Unknown weed" and take a sample or photograph, do not try to guess. If more than one weed species is present then repeat the process with separate records for each species.

### 2. Assess the 'best fit' width in metres of the linear weed area.

Look along the area of weeds to the furthest weed plant and decide a width that best sums up the width of the infestation from values of 5, 20, 50 or 100 metres. If the width is too variable you may need to make more than one line or consider recording as points or as a polygon.

### 3. Assess the density of weeds within the line.

For the area of the line, being from start to finish at the designated width, decide the area covered by weeds. Assign a score from 2 to 5 based on the percentage table below. Consider the whole line area when deciding on the density score. Area covered should be determined by a 'projected canopy' method.

#### Density categories

1 = Absent, no weeds of this species in this area.

2 = < 1%, Very few, not many weeds eg: single plant, perhaps with seedlings.

3 = 1 -10%, More than one or two isolated plants but not a lot eg: a few small plants.

4 = 11-50%, A lot, up to half the area covered eg: a tree, dense patches of weeds.

5 = > 50%, Dominant cover is weed, more than half covered eg: thickets, monocultures.

### 4. Record the location.

Start the GPS track, or line sketch from one end of the linear weed area. Walk or sketch a line as best fit through the middle of the linear weed area and finish at the end point.

### 5. Record the treatment.

Record the method you apply a treatment to the weeds, or record 'No Treatment'.

Choose from the list of treatment methods

ie: No treatment, Unknown, Treated, Foliar spray etc.

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## How to record weed area as a polygon record

### 1. Record the species.

When a weed is sighted, move to the area and confirm identification of the weed. If you cannot positively identify the weed record it as "Unknown weed" and take a sample or photograph, do not try to guess. If more than one weed species is present then repeat the process with separate records for each species.

### 2. Assess the extent of the weed area and ensure it can be practically enclosed.

Polygons are good for clearly delineated areas of weeds, you should be able to walk around the edge of the weed area with confidence. Ensure the defined area of weed at a similar density can be delineated before attempting to create the area, you may need more than one polygon. If the area is poorly defined then the point method may be a more useful.

### 3. Assess the density of weeds within the polygon.

Assess the area covered by weeds for density, you may need to move to several vantage points to get a clear picture. Assign a score from 2 to 5 based on the percentage table below. Consider the whole area within the polygon when deciding on the density score. Area covered should be determined by a 'projected canopy' method.

#### Density categories

1 = Absent, no weeds of this species in this area.

2 = < 1%, Very few, not many weeds eg: single plant, perhaps with seedlings.

3 = 1 -10%, More than one or two isolated plants but not a lot eg: a few small plants.

4 = 11-50%, A lot, up to half the area covered eg: a tree, dense patches of weeds.

5 = > 50%, Dominant cover is weed, more than half covered eg: thickets, monocultures.

### 4. Record the location.

Start the GPS track, or polygon sketch from one point of the polygon weed area. It is useful to start from a landmark or flagging tape. Create the polygon edge line by walk a path or sketching along the outer edge of the weed area until you return to the start point. If using a GPS track to create the polygon ensure that you cross your start point so as to close the polygon.

### 5. Record the treatment.

Record the method you apply a treatment to the weeds in the area, or record 'No Treatment'. Choose from the list of treatment methods

ie: No treatment, Unknown, Treated, Foliar spray etc.

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# Weed Management Plan

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## Appendix B Example Weed Data Collection Sheet

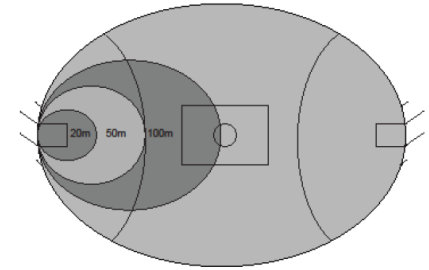
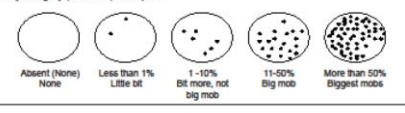
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RECORDER:				PROJECT:				LOCALITY:						
ORG_NAME:				GPS NAME/MODEL:				RECORDING METHOD :						
SITE_ID	DATE_REC	LAT_G94	LONG_G94	WEED_NAME	SIZE_DIA_M	DENS_CAT	SEEDLINGS	JUVENILES	ADULTS	SEED_PRES	PAST_TREAT	TREATMENT	HERBICIDE	COMMENTS

**Notes:**

<p><b>Treatment method</b> Control method applied today as per below. If none, record 'No treatment'</p> <ul style="list-style-type: none"> <li>- Foliar spray</li> <li>- Residual application</li> <li>- Basal bark</li> <li>- Cut stump</li> <li>- Stem injection</li> <li>- Aerial spray</li> <li>- Slashed or cut</li> <li>- Hand pull</li> </ul> <p><b>Herbicide</b> The active ingredient(s) of the herbicide applied today (if any) <b>GPS waypt</b> Waypoint ID as entered in the GPS <b>Weed name</b> Common name or scientific name for the weed recorded <b>S (y/n)</b> Seedlings: Are seedlings visible? <b>J (y/n)</b> Juveniles: Are juvenile plants visible? <b>A (y/n)</b> Adults: Are there adult plants, or seeds, or evidence of past seeding present? <b>Seed (y/n)</b> Seeds: Are seeds visible today? Or plants with seeds or pods? <b>Treat (y/n)</b> Treatment: Did you apply treatment to this site? <b>Comment</b> Record any notes for yourself here.</p>	<p><b>Size dia m</b> Size/diameter of the area you are recording information about (in metres). Use 20m, 50m or 100m.</p>  <p>Example of size/diameter compared to a football oval. (Sizes 20m, 50m, 100m)</p>	<p><b>Dens cat</b> Density of weeds in the assessed area using categories described below</p> <table border="1"> <tr> <td>1 = No weeds (absent)</td> <td>2 = Single plant or very few (&lt;1%)</td> <td>3 = A few plants (1-10%)</td> </tr> <tr> <td>4 = Many weeds, up to half (11 - 50%)</td> <td>5 = Mostly weeds, more than 50%</td> <td>6 = Density not assessed</td> </tr> </table> <p><b>Density category (Dens cat) examples</b></p> 	1 = No weeds (absent)	2 = Single plant or very few (<1%)	3 = A few plants (1-10%)	4 = Many weeds, up to half (11 - 50%)	5 = Mostly weeds, more than 50%	6 = Density not assessed
1 = No weeds (absent)	2 = Single plant or very few (<1%)	3 = A few plants (1-10%)						
4 = Many weeds, up to half (11 - 50%)	5 = Mostly weeds, more than 50%	6 = Density not assessed						

(extracted from Northern Territory Weed Data Collection Manual - Section One Technical Data Description.

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**Appendix E Erosion and Sediment Control Plan**





# Primary Erosion and Sediment Control Plan

NT-2050-15-MP-019.

## BEETALOO BASIN EXPLORATION PROJECT Primary Erosion and Sediment Control Plan

### EP76, EP98 and EP117

This document outlines the basic principles for Contractors to develop site specific erosion and sediment control plans for Beetaloo Basin Exploration Program.

#### Review record

Rev	Date	Reason for issue	Reviewer/s	Consolidator	Approver
0	29/03/2019	Issued for use	A.Court	M.Kernke	M.Hanson
1	28/06/2019	Revised based on comments received by DENR	A.Court/J.Jentz	M.Kernke	M.Hanson
2	16/07/2019	Updated Primary ESCP	A.Court/J.Jentz	M.Kenke	M.Hanson

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# Primary Erosion and Sediment Control Plan

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Table 9 Measures to be implemented for Erosion and Sediment Control

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## 1. Introduction

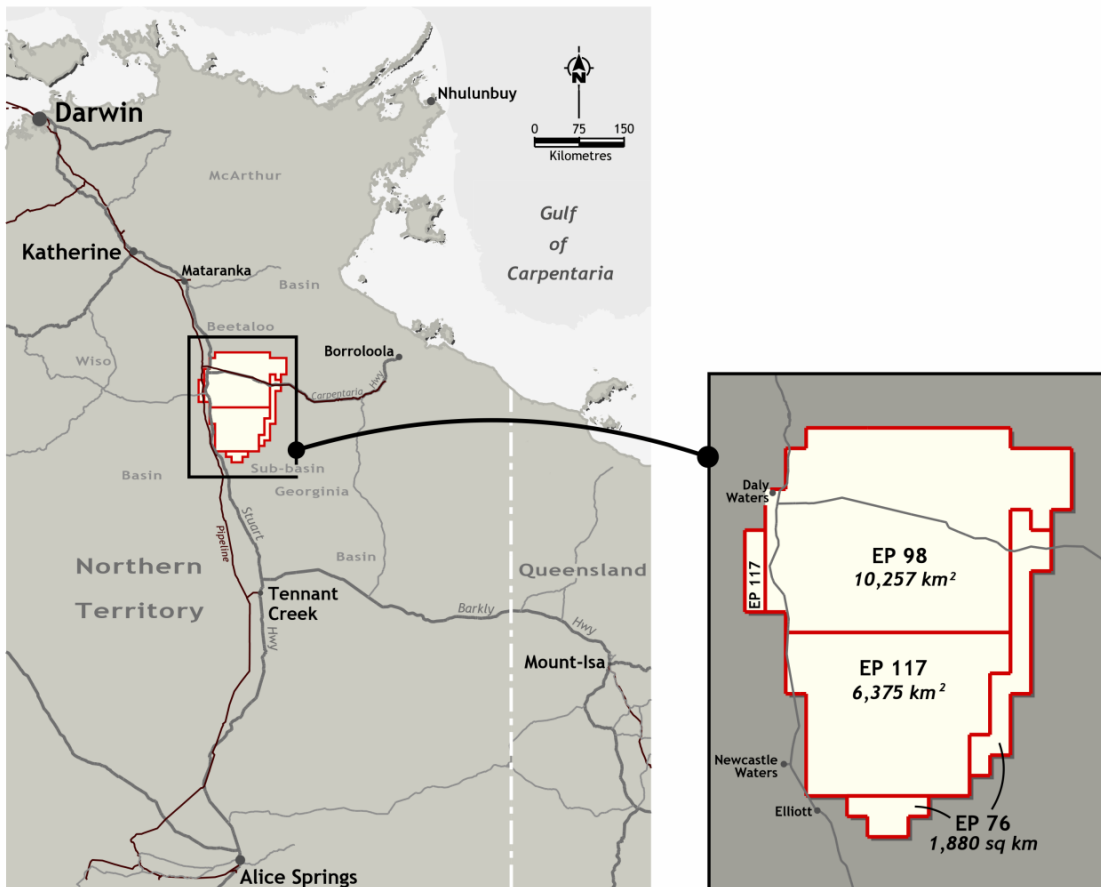
This Primary Erosion and Sediment Control Plan (ESCP) has been developed to ensure best practice erosion and sediment controls are implemented during Origin Exploration activities within permit EP76, EP98 and EP117 to prevent erosion and offsite impacts such as sedimentation of waterways.

This ESCP has been developed to provide directions for Origin and contractors to implement erosion and sediment control (ESC) during construction of the lease pads and associated infrastructure, worker camps and access tracks as well as during ongoing maintenance and monitoring once sites are established.

The design of the lease pads and access tracks will comply with Northern Territory and local government statutory laws and regulations and are to be designed to meet all relevant and applicable codes and standards. This ESCP has been developed in accordance with the following guidelines:

- *Code of Practice for Petroleum Activities in the Northern Territory* (DENR, 2019)
- *Best Practice Erosion and Sediment Control* (IECA, 2008)
- *Land Clearing Guidelines* (DENR, 2019)
- *Erosion and Sediment Control Guidelines for Rural Development Environment Fact Sheet* (DLRM, 2018).

The location of the proposed exploration activities are shown on **Figure 1**.



**Figure 1** Location of Origin Permit Area

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# Primary Erosion and Sediment Control Plan

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## 2. Project Context

This plan covers all civil, drilling, stimulating, rehabilitation and routine maintenance/monitoring activities undertaken by Origin and their contractors within permit EP76, EP98 and EP117 as detailed in Table 1 and shown in **Figure 2**. The proposed activities for the 2019/2020 program are highlighted within the table.

**Table 1** Coordinates of centroid of proposed exploration lease areas

Exploration Permit	Lease Name	Zone*	Easting	Northing
EP98	Velkerri 98 E1-	53	415515	8180683
EP98	Velkerri 98 N1	53	392292	8189891
EP98	Kyalla 98 W1	53	364955	8177458
EP76	Velkerri 76 S1	53	424362	8113273
EP76	Velkerri 76 S2	53	435488	8136321
EP117	Kyalla 117 N2	53	356175	8137500
EP117	Stuart Highway Intersection	53	332371	8135170
EP117	Velkerri 117 E1	53	428861	8120782
EP117	Kyalla 117 W1	53	368079	8106696

*Grey shading are planned for 2019/2020*

*\* Universal Transverse Mercator (UTM) geographic coordinate system is Geocentric Datum of Australia (GDA) 94.*

The primary activities subject to this ESCP are:

- Construction of a 5.5-ha lease pad at Kyalla 117 N2 and Velkerri 76 S2.
- Construction of a 1.2-ha camp pad at Kyalla 117 N2 and Velkerri 76 S2.
- Construction of a 0.2-ha stockpile area at Kyalla 117 N2 and Velkerri 76 S2.
- Construction of a 0.25-ha helipad and 1-ha wet weather storage area at the Velkerri 76 S2.
- Construct a 650 m long x 8 m wide (0.52-ha) lease pad turn in to Kyalla 117 N2 connecting the proposed lease pad to the existing access track.
- Construct a 1,100 m long x 8 m wide (0.88-ha) lease pad turn in to Velkerri 76 S2 connecting the proposed lease pad to the existing access track.
- Minor intersection upgrade works at the intersection with the Stuart Highway of approximately 0.5-ha in accordance with approved Road Agency approval (2018-0186-D2) and Permit to Work within NT Government Road Reserve.
- Utilise approximately 107 km of existing access track.
- Obtain gravels, as required, for construction of drill pads and sections of the access track at up to seven proposed borrow pits (7 gravel pits up to 1 to 2.1 ha).
- All other activities ancillary to the drilling, stimulation and well testing of an exploration well.

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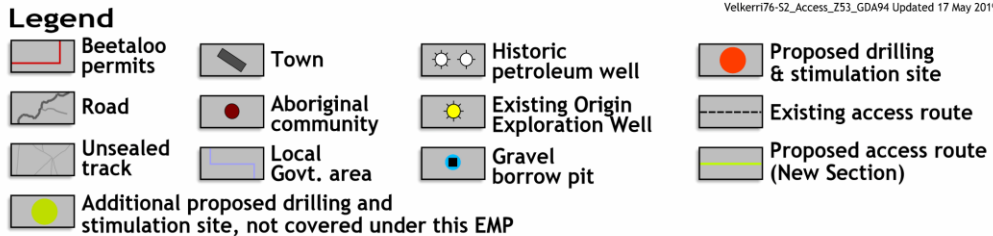
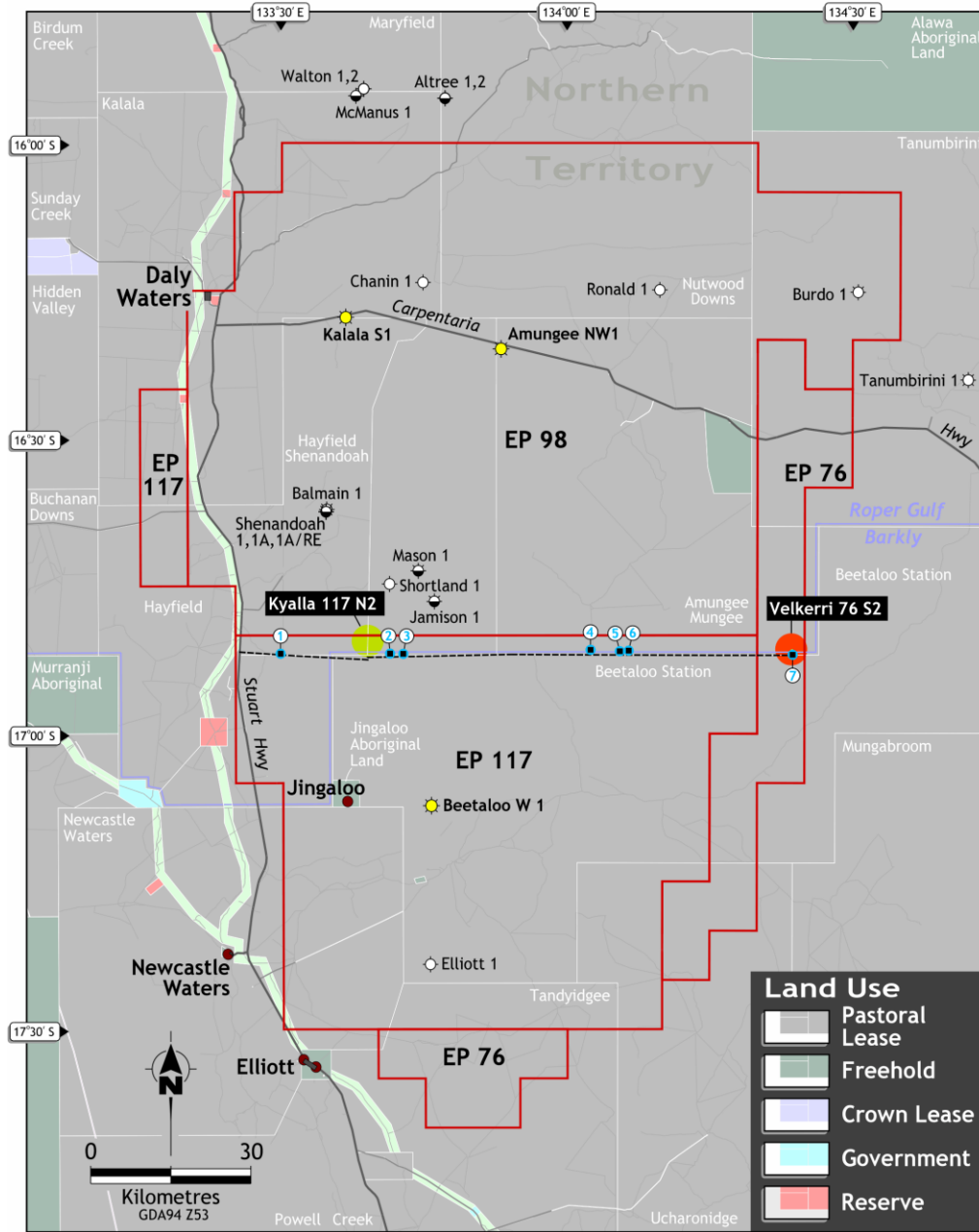


Figure 2 Location of 2019 Exploration Lease Areas

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# Primary Erosion and Sediment Control Plan

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## 3. Disturbance Area

The proposed locations of the infrastructure are within the Northern Land Council (NLC) and Aboriginal Area Protection Authority (AAPA) cleared subject land area. It is noted that the nominated areas for infrastructure may be changed slightly to minimise environmental and heritage impacts (e.g. significant tree or habitat avoidance, or any chance-finds with archaeological artefacts). Such modification will be made within the existing surveyed areas and under the supervision of Origin representative.

**Table 2 Proposed 2019/2020 infrastructure location and disturbance area**

Exploration Permit	Infrastructure Name	Station	Zone*	Approx. Easting	Approx. Northing	Disturbance Area (ha)
<b>Kyalla 117 N2 Disturbance Areas</b>						
EP117	Kyalla 117 N2 well Pad	Hayfield/Shenandoah	53	356175	8137500	5.5
EP117	Camp lease pad	Hayfield/Shenandoah	53	356400	8137820	1.2
EP117	Stockpile laydown	Hayfield/Shenandoah	53	356394	8137628	0.2
EP117	Gravel Pit 1	Hayfield/Shenandoah	53	339883	8135006	1.5
EP117	Gravel Pit 2	Hayfield/Shenandoah	53	360367	8135138	1.0
EP117	Gravel Pit 3	Hayfield/Shenandoah	53	362842	8135102	1.0
EP117	Access tracks	Hayfield/Shenandoah	53	356192	8138070	1.0
<b>Total Kyalla 117 N2 Disturbance Area (Ha)</b>						<b>11.4</b>
<b>Velkerri 76 S2 Disturbance Areas</b>						
EP76	Velkerri 76 S2 well Pad	Amungee Mungee	53	435557	8137497	5.5
EP76	Camp lease pad	Amungee Mungee	53	435882	8136267	1.2
EP76	Stockpile laydown	Amungee Mungee	53	435632	8136163	0.2
E76	Helipad	Amungee Mungee	53	435632	8136246	0.5
EP117	Gravel Pit 4	Amungee Mungee	53	397906	8136039	1.5
EP117	Gravel Pit 5	Amungee Mungee	53	403386	8135809	1.0
EP117	Access tracks	Amungee Mungee	53	-	-	2.4
EP117	Gravel Pit 6	Amungee Mungee	53	405049	8135927	1.0
EP 117	Gravel Pit 7	Amungee Mungee	53	435749	8135306	0.5
<b>Total Velkerri 76 S2 Disturbance Area (Ha)</b>						<b>13.8</b>
<b>Stuart Highway Disturbance Area</b>						
EP117	Stuart Highway	Hayfield/Shenandoah	53	332371	8135170	0.5
<b>Total Stuart Highway Disturbance Area (Ha)</b>						<b>0.5</b>
<b>Total Disturbance Area (Ha)</b>						<b>25.7</b>

\* Universal Transverse Mercator (UTM) geographic coordinate system is Geocentric Datum of Australia (GDA) 94.

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# Primary Erosion and Sediment Control Plan

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## 4. Aim and Objective

The Primary ESCP aims to:

- Address key soil and water management issues, including legislative and client requirements.
- Determine the “Type” of ESC to be implemented during construction, post construction and until exploration activities are completed.
- Where practical identify, eliminate and reduce hazards and associated risks inherent in specific work activities, which if untreated could lead to a diminished product or create the potential for an accident, dangerous occurrence or environmental incident.

The objective of this Primary ESCP is to manage Origin’s activities within the Permit Area in a manner that minimises the impacts upon soil, vegetation and surface water which may result from soil disturbance activities including land clearing and lease pad establishment. Where additional ESCP is considered required, or controls to be initiated, a Secondary ESCP, as described in the *Code of Practice: Onshore Petroleum Activities in the Northern Territory* (DENR 2019), will be prepared by suitably qualified person in relation to the matters identified in the Primary ESCP.

This ESCP may be amended as required, in response to the Monitoring and Maintenance Programs described herein to avoid significant and/or sustained deterioration in downstream water quality. Standard drawings are provided as a guide, with the Construction Supervisor and Origin Engineers making final determination on site.

Strategies shall be developed, implemented and reviewed on a regular basis, so that risks are identified, measured and recorded throughout the course of the project.

Any changes to the ESCP or the preparation of Secondary ESCP will be subject to review and approval by the DENR Land Management Team.

### 4.1 Compliance with IECA Guideline

The Primary ESCP has been prepared by suitably qualified and experienced personnel that understand the intent and minimum standards of IECA. The team that prepared the plan consist of the following:

- Alana Court – BEnvSci, PGDipEnvMgt. Principal Environmental Scientist with over 18 years’ experience and completed the IECA erosion and sediment control training (2013). Over 10 years’ experience providing advice to managing environmental requirements in the Beetaloo Basin including erosion and sediment control.
- James Jentz – BEng, RPEQ, CPEng. Civil Engineer with over 30 years’ experience in the design and documentation of civil engineering projects. James has signed off all civil drawing under his qualification.

## 5. Civil Construction Schedule

The current proposed Civil Construction schedule for Origin’s activities for the 2019/2020 exploration program at for Kyalla 117 N2 and Velkerri 76 S2 is detailed in the Gantt Chart below (Figure 3). The civil construction activities are planned to occur during the dry season between July 2019 to September 2019 while rainfall risk rating is considered very low (0 to 30 mm).

Implementation of the ESCP will commence as soon as access is granted and continued throughout the construction activities until such time that the site is stabilised.

In the event that civil construction activities continue through to the wet season, the ESCP will undergo a review and a Secondary ESCP specific to wet season conditions will be prepared. This revision will occur during October for approval by DENR Land Management Team and will be implemented between 1 November to the 31<sup>st</sup> March, based on the rainfall conditions in that permit area.

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Beetaloo: Kyalla117 & Velkerri 76 Civil Construction Activities

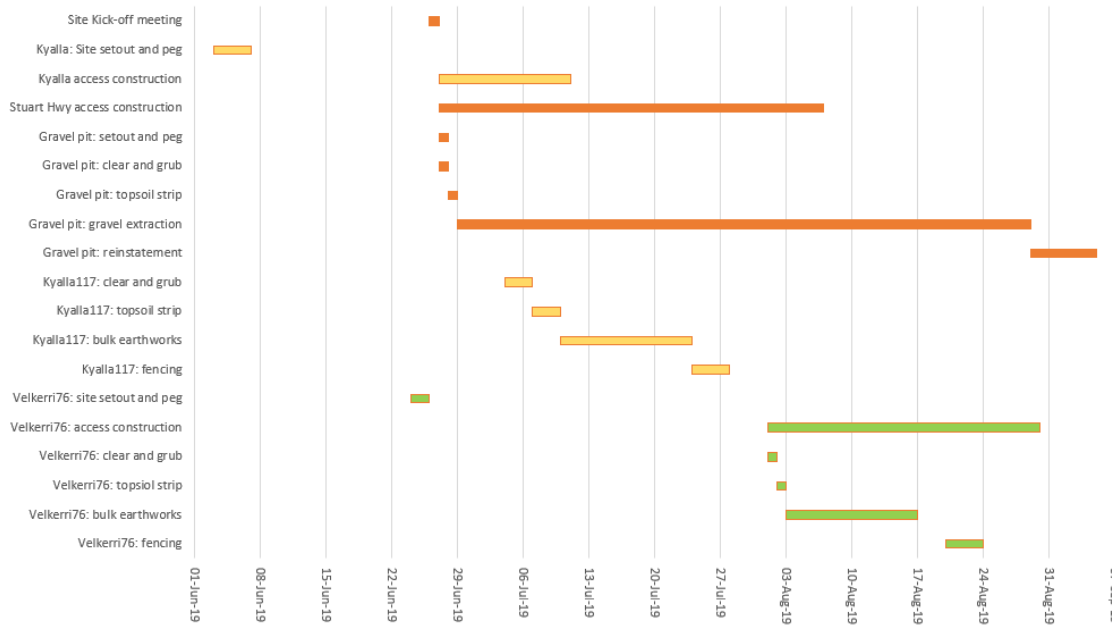


Figure 3 Proposed Civil Construction Schedule

## 6. Permit Area Erosion Susceptibility

Erosion susceptibility varies throughout the Origin permit area, dependent upon the soil types, slope and extent of ground disturbance. Apart from the erosive impact of climatic conditions, soil erosion is influenced mainly by the inherent properties of the soils and the processes which occurred during the formation of the landscapes.

Erosion will occur in the permit area if the land is used beyond its capacity, as is seen if land is overstocked or vehicle movements not controlled, for example. The locations of the proposed lease areas for 2019/2020 program have been examined in the field to determine the risk of erosion occurring from Origin activities.

Factors considered include the following:

- Soil type – soils with higher clay content are prone to generation of bulldust and are easily eroded by wind and water. Gravelly soils tend to be more robust to disturbance on the scale expected for Origin exploration activities. The primary soil type encountered during the geotechnical investigations for the 2019/2010 lease areas (Kyalla 117 N2 and Velkerri 76 S2) can be described as silty SAND, SM with some gravel. These soils are considered to have a low to medium erodibility potential when the soils are disturbed.
- Slope – the slope of the site is one of the characteristics that will help to determine the risk of erosion during rainfall events, with steeply inclined areas a higher risk than small undulations in the landform. The proposed drilling locations were flat with a slope of <1%.
- Aspect – the position of the access track and pads in relation to the direction of the contour should be considered and creation of tracks and the lease pads across (as opposed to parallel with) the contour should be avoided.
- Rainfall – Table 3 and Table 4 present the erosion risk rating based on average monthly rainfall using the rating system provided in the IECA (2008) Table 4.4.2 for Daly Waters (northern sites) and Newcastle Waters (southern sites). The construction activities for the exploration program are proposed to be completed during the 2019 dry season.

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# Primary Erosion and Sediment Control Plan

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**Table 3 Erosion Risk Rating based on average monthly rainfall at Daly Waters**

-Item	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	165.4	165.4	120.1	23.6	5.0	5.6	1.5	1.7	4.9	22.5	59.4	110
Erosion Risk*	H	H	H	VL	VL	VL	VL	VL	VL	VL	M	H

\* **E** = Extreme (>225 mm); **H** = High (100+ to 225 mm); **M** = Moderate (45+ to 100 mm); **L** = Low (30+ to 45 mm); **VL** = Very Low (0 to 30 mm)

**Table 4 Erosion Risk Rating based on average monthly rainfall at Newcastle Waters**

Item	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	125.5	130.9	93.7	24.6	9.3	5.3	3.4	1.0	5.4	20.9	35.7	77.3
Erosion Risk*	H	H	M	VL	VL	VL	VL	VL	VL	VL	L	M

\* **E** = Extreme (>225 mm); **H** = High (100+ to 225 mm); **M** = Moderate (45+ to 100 mm); **L** = Low (30+ to 45 mm); **VL** = Very Low (0 to 30 mm)

## 6.1 Erosion Hazard Assessment for Kyalla 117 N2 and Velkerri 76 S2

An Erosion Hazard Assessment for Kyalla 117 N2 and Velkerri 76 S2 lease area, and the Stuart Highway turning has been conducted to inform the specific issues and actions that will be required for conducting activities within the permit area. Table 5 presents the results of the assessment. The IECA (2008) Explanatory Notes for the assessment are presented **Appendix A**.

**Table 5 Erosion Hazard Assessment for Kyalla 117 N2, Velkerri 76 S2 and Stuart Highway Access**

Condition (as described by IECA, 2008)	Points	Score			Trigger value
		Kyalla 117 N2	Velkerri 76 S2	Stuart Highway Access	
<b>AVERAGE SLOPE OF DISTURBANCE AREA [1]</b>					
<ul style="list-style-type: none"> <li>not more than 3% [3% <math>\approx</math> 33H:1V]</li> </ul>	0	0	0	0	4
<ul style="list-style-type: none"> <li>more than 3% but not more than 5% [5% = 20H:1V]</li> </ul>	1	<b>Comment</b> - Topographical survey of lease areas indicated (low relief) with a slope <1% (refer <b>Appendix B</b> )			
<ul style="list-style-type: none"> <li>more than 5% but not more than 10% [10% = 10H:1V]</li> </ul>	2				
<ul style="list-style-type: none"> <li>more than 10% but not more than 15% [15% <math>\approx</math> 6.7H:1V]</li> </ul>	4				
<ul style="list-style-type: none"> <li>more than 15%</li> </ul>	6				
<b>SOIL CLASSIFICATION GROUP (AS1726) [2]</b>					
<ul style="list-style-type: none"> <li>GW, GP, GM, GC</li> </ul>	0	2	2	2	-
<ul style="list-style-type: none"> <li>SW, SP, OL, OH</li> </ul>	1	<b>Comment</b> – Geotechnical testing indicated SM - Silty sands, poorly graded sand-silt mixtures (refer <b>Appendix C</b> ).			
<ul style="list-style-type: none"> <li>SM, SC, MH, CH</li> </ul>	2				
<ul style="list-style-type: none"> <li>ML, CL, or if imported fill is used, or if soils are untested</li> </ul>	3				
<b>EMERSON (DISPERSION) CLASS NUMBER [3]</b>					
<ul style="list-style-type: none"> <li>Class 4, 6, 7, or 8</li> </ul>	0	0	0	0	6
<ul style="list-style-type: none"> <li>Class 5</li> </ul>	2	<b>Comment</b> – Class 4 – Sand Material, therefore Emerson test not applicable.			
<ul style="list-style-type: none"> <li>Class 3, (default value if soils are untested)</li> </ul>	4				
<ul style="list-style-type: none"> <li>Class 1 or 2</li> </ul>	6				
<b>DURATION OF SOIL DISTURBANCE [4]</b>					
<ul style="list-style-type: none"> <li>not more than 1 month</li> </ul>	0	2	2	0	6

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Condition (as described by IECA, 2008)	Points	Score			Trigger value
		Kyalla 117 N2	Velkerri 76 S2	Stuart Highway Access	
<ul style="list-style-type: none"> <li>more than 1 month but not more than 4 months</li> <li>more than 4 months but not more than 6 months</li> <li>more than 6 months</li> </ul>	2 4 6	<b>Comment</b> – Clearing and earthworks are expected to be between 1 and 4 months.			
<b>AREA OF DISTURBANCE [5]</b>					
<ul style="list-style-type: none"> <li>not more than 1000 m2</li> <li>more than 1000 m2 but not more than 5000 m2</li> <li>more than 5000 m2 but not more than 1 ha</li> <li>more than 1 ha but not more than 4 ha</li> <li>more than 4 ha</li> </ul>	0 1 2 4 6	6 7.9 ha	6 9.7 ha	1 0.5 ha	6
<b>WATERWAY DISTURBANCE [6]</b>					
<ul style="list-style-type: none"> <li>No disturbance to a watercourse, open drain or channel</li> <li>Involves disturbance to a constructed open drain or channel</li> <li>Involves disturbance to a natural watercourse</li> </ul>	0 1 2	0	0	1	2
<b>REHABILITATION METHOD [7]</b> Percentage of area (relative to total disturbance) revegetated by seeding without light mulching (i.e. worst-case revegetation method).					
<ul style="list-style-type: none"> <li>not more than 1%</li> <li>more than 1% but not more than 5%</li> <li>more than 5% but not more than 10%</li> <li>more than 10%</li> </ul>	1 2 3 4	1	1	1	-
<b>RECEIVING WATERS [8]</b>					
<ul style="list-style-type: none"> <li>Saline waters only</li> <li>Freshwater body (e.g. creek or freshwater lake or river)</li> </ul>	0 2	2	2	2	-
<b>SUBSOIL EXPOSURE [9]</b>					
<ul style="list-style-type: none"> <li>No subsoil exposure except of service trenches</li> <li>Subsoils are likely to be exposed</li> </ul>	0 2	0	0	0	-
<b>EXTERNAL CATCHMENTS [10]</b>					
<ul style="list-style-type: none"> <li>No external catchment</li> <li>External catchment diverted around the soil disturbance</li> <li>External catchment not diverted around the soil disturbance</li> </ul>	0 1 2	1	1	1	-
<b>ROAD CONSTRUCTION [11]</b>					
<ul style="list-style-type: none"> <li>No road construction</li> <li>Involves road construction works</li> </ul>	0 2	2	2	2	-
<b>pH OF SOILS TO BE REVEGETATED [12]</b>					
<ul style="list-style-type: none"> <li>more than pH 5.5 but less than pH 8</li> <li>other pH values, or if soils are untested</li> </ul>	0 1	1	1	1	-
<b>Total Score [13]</b>		<b>17</b>	<b>17</b>	<b>13</b>	

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The Erosion Hazard Assessment for the Origin permit area proposed for the 2019/2020 program all report either equal to or below point score of 17, ranging from 13 points at the Stuart Highway turn-in and 17 at both lease pads. Based on the trigger value being met at the two lease pads an ESCP is required.

## 6.2 Soil Loss Estimate

IECA (2008) soil loss estimation has been used to determine the type of controls the project should adopt to limit soil loss during construction when soils are exposed to rainfall. Long term average soil loss resulting from sheet and rill flow can be predicted using the Revised Universal Soil Loss Equation (RUSLE).

Soil loss calculated using RUSLE for the project area was calculated as follows:

$$A = R \cdot K \cdot LS \cdot C \cdot P$$

Where A = annual soil loss due to erosion [tonnes/hectare/year (t/ha/yr)]

R = rainfall erosivity factor based on = **6297**)

K = soil erodibility factor of **0.055** for silty sand)

LS = topographic factor derived from slope length and slope gradient (**0.24**)

C = cover and management factor (**1**)

P = erosion control practice factor (**1.3**)

It is noted that the **annual R-factor of 6297** for the Katherine Region has been adopted as per comment received by DENR Land Management team. Since preparation of the initial ESCP, additional geotechnical information has been obtained which provides a larger sample size of the proposed permit areas. The geotechnical sampling completed on the sites has shown that the top 0.3 m of the site is "Silty Sand". As such, the K-factor has been revised to 0.055 for "Silty Loam" from Table E4 of the IECA Guidelines.

Revision of the LS-factor on more detailed design drawings shows a total slope length of approx. 200 m at a gradient of 0.00120 m/m (0.12%), indicative of the gradients across both sites. A LS factor of 0.24 was adopted, indicating a 200 m slope at 0.01 m/m (1%).

Based on the reviewed RUSLE soil loss methodology, **the Annual Soil Loss estimate using these values is 108 t/ha/yr**. Type 3 sediment controls are adequate with the revision to the RUSLE equation. In addition, Type 2 controls have been allowed for in design including settlement pond on the drill pads and rock filter dams at the Stuart Highway Intersection.

All the proposed civil construction activities for the exploration program are proposed to be completed during the 2019 dry season (July to October) when the erosion risk rating for rainfall is very low (refer to Table 3 and Table 4).

## 6.3 Erosion Risk and Determination of ESC

Erosion risk ratings for the Project area have been determined based on the average monthly erosivity (R-factor of 6297), average monthly rainfall depth (mm) (refer Table 3 and Table 4 above) and soil loss (estimated at 108t/ha/yr). As indicated in Table 6, the Project has an erosion risk rating of "very low" to "extreme".

**Table 6 Erosion Risk Rating (adapted from IECA, 2008, Tables 4.4.1, 4.4.2 and 4.4.3)**

Erosion Risk Rating	Average Monthly Erosivity (R-Factor)	Average Monthly Rainfall Depth (mm)	Soil Loss (t/ha/yr)
Very Low	0 to 60	0 to 30*	0 to 150
Low	60+ to 100	30+ to 45	150+ to 225
Moderate	100+ to 285	45+ to 100	225+ to 500
High	285+ to 1,500	100+ to 225	500+ to 1,500
Extreme	>1,500*	>225	>1,500

\* It is noted that the monthly erosivity factor would only be triggered during rainfall events. The construction period is proposed to occur from July to October and based on assessment of the average monthly rainfall for the

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region (refer Table 3 and Table 4), the erosion risk rating is considered very low (0 to 30mm during this time). It is anticipated that at completion of construction the site would be stabilised for normal operation.

Table 7, provides an indication of the "Type" of erosion and sediment controls that should be deployed during construction depending on annual soil loss. Based on the proposed construction schedule during the dry season, the Project is determined to trigger the use of Type 3 erosion and sediment controls, with some Type 2 controls allowed for in design including settlement pond on the drill pads and rock filter dams at the Stuart Highway Intersection.

**Table 7 Sediment Control Standard (adapted from IECA, 2008, Table 4.5.1)**

Catchment Area (m <sup>2</sup> )	Soil Loss Rate Limit (t/ha/yr)		
	Type 1	Type 2	Type 3
250	N/A	N/A	All Cases
1000	N/A	N/A	All Cases
2500	N/A	>75	75
>2500	>150	150	75

Table 8 provides a range of erosion and sediment controls that can be deployed on the Project for each 'Erosion and Sediment Control Type'.

**Table 8 Classifications of Sediment Controls**

Type 1	Type 2	Type 3
<b>Sheet Flow</b>		
Buffer Zone capable of infiltrating 100% of stormwater runoff or processed water Infiltration basin or sand filter bed capable of infiltration of 100% of flow	Buffer Zone capable of infiltrating 100% of stormwater runoff <b>Compost/Mulch Berm</b>	<b>Buffer Zone capable of infiltrating 100% of stormwater runoff</b> Filter Fence Modular Sediment Trap Sediment Fence
<b>Concentrated Flow</b>		
Sediment basin (sized in accordance with design standard)	Block and Aggregate Drop Inlet Protection Excavated Sediment Trap with Type 2 outlet Filter Sock Filter Tube Dam Mesh and Aggregate Drop Inlet Protection Rock and Aggregate Drop Inlet Protection Rock Filter Dam Sediment Trench Sediment Weir	Coarse Sediment Trap Excavated Drop Inlet Protection Excavated Sediment Trap with Type 3 Outlet Fabric Drop Inlet Protection Fabric Wrap Field Inlet Sediment Trap Modular Sediment Trap Straw Bale Barrier (not desirable) U-shaped Sediment Trap
<b>Dewatering Sediment Control</b>		
Type F/D Sediment Basin Stilling Pond	Filter Bag or Filter Tube Filter Pond Filter Tube Dam Portable Sediment Tank Settling Pond Sump Pit	Compost Berm Filter Fence Grass Filter Bed Hydrocyclone Portable Sediment Tank Sediment Fence

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Type 1	Type 2	Type 3
<b>In-stream sediment control</b>		
Pump sediment laden water to an off-stream Type F/D Sediment Basin or high filtration system	Filter Tube Barrier Modular Sediment Barrier Rock Filter Dam Sediment Weir	Modular Sediment Barrier Sediment Filter Cage

Standard drawings for erosion and sediment controls are available at:

<http://www.austieca.com.au/publications/book-6-standard-drawings>.

The proposed ESCP for Kyalla 117 N2 and Velkerri 76 S2 lease area, the Stuart Highway turn-in and typical cross section for water crossings are provided in **Appendix E**, **Appendix F**, **Appendix G** and **Appendix H**, respectively.

Standard drawings that may be applicable for the Project, including controls for access tracks and stream crossings are provided in **Appendix I**. The final design of the ESC controls will be dependent on decisions made in the field by the Supervising Engineer and site conditions. Any significant changes to those identified in this ESCP will be reported through to DENR Land Management Team for review and approval. Origin and its civil contractors will be responsible for notifying of any changes.

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## 7. Erosion and Sediment Controls

Based on the erosion susceptibility of the exploration area, the ESCP measures to be adopted for the 2019/2020 program are summarised in Table 9 below. These ESCP measures have been considered during the design and will be implemented by the Civil Contractors during the construction activities.

**Table 9 Measures to be implemented for Erosion and Sediment Control**

Activity	Management Controls
<p><b>Land Clearing</b></p>	<ul style="list-style-type: none"> <li>- Undertake selective clearing (only clearing areas that are necessary for construction and ESC activities), using lighter machinery such as graders or smaller bulldozers, taking care not to overwork the site. Overworking the site can lead to the loss of topsoil, compaction, formation of windrows and wheel rutting.</li> <li>- Minimise tree clearing activities only during the dry season (April to October) to allow the ground surface to stabilise before the onset of the wet season (November to March).</li> <li>- Retain vegetation buffers surrounding streams and creeks, as outlined in the <i>NTG Land Clearing Guidelines 2010</i>.</li> <li>- Undertake clearing for each stage in small units over time, keeping the disturbed areas small and time of exposure short, in conjunction with progressive re-vegetation (assisted natural regeneration using available topsoil).</li> <li>- Take all reasonable and practicable measures to minimise the removal of, or disturbance to, trees, shrubs and ground covers (organic or inorganic) that are to be retained.</li> <li>- If bulk tree clearing is required, it must occur in a manner that minimises disturbance to existing ground cover (organic or inorganic).</li> <li>- Bulk tree clearing and grubbing of the site must be immediately followed by specified temporary stabilisation measures (e.g. gravel, soil berm) prior to commencement of each stage of construction works.</li> <li>- Land clearing should not occur unless preceded by the installation of appropriate drainage and sediment control measures. The exception would be any land clearing necessary to allow installation of these control measures. Prior to land clearing, establish tree protection zones around vegetation to be retained e.g. identify with high-visibility tape, or light fencing.</li> <li>- All land clearing must be in accordance with the Federal, Territory and local government vegetation clearing requirements and IECA Table 4.4.7 Best practice land clearing and rehabilitation requirements.</li> <li>- All reasonable and practicable steps to be taken to apply best practice Erosion control measures following earthworks and site stabilised prior to anticipated rainfall. Disturbed areas will be stabilised with a minimum 60% cover within 30 days of completion if rainfall is reasonably possible.</li> </ul>

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Activity	Management Controls
<p><b>Access Track and Stuart Highway Turn-in Construction</b></p>	<ul style="list-style-type: none"> <li>- Where possible, use existing roads and tracks to access the lease areas, and where new tracks are required, they should be located along the most direct and practicable route to the lease area (noting Velkerri 76 S1 access track has been diverted around the sensitive Bullwaddy/Lancewood vegetation type).</li> <li>- Trucks entering and exiting the site will be constrained in such a manner to prevent dropping or tracking material on the Highway in accordance with the Road Agency Approval (ref 2018-0186-D2).</li> <li>- Monitor Stuart Highway during construction and operation. Where tracked material on the road pavement becomes a potential safety issue, Origin and its contractors will sweep and clean material off the road. If Stuart Highway Turn-in results in dust, dirt creating hazard to road users, additional ESC will be considered including installation of shaker grid or rock pad.</li> <li>- Minimise track width and surface disturbance (e.g. topsoil, seed and root stock) as far as practicable to allow safe passage of required equipment. Disturbed areas will be stabilised with a minimum 60% cover 30 days of completion if rainfall possible.</li> <li>- Where gravelling is warranted (Stuart Highway Turn-in), the formation process can remove undesirable material and/or box the imported material where it is required. Track formation will be required for the following reasons:             <ul style="list-style-type: none"> <li>• Drainage control, especially in areas where erosion or sediment influences are evident, any vegetation, topography, wheel rutting or compaction is likely to intercept, concentrate and channel water.</li> <li>• Where the topography of the track location or the drainage characteristics of the soil are likely to hinder access for a protracted time period following rain (e.g. 1 to 2 weeks).</li> <li>• Where natural side-slope poses a safety hazard to potential users of the track (e.g. Contractors, Land Owners).</li> </ul> </li> <li>- Place scrub and vegetation cleared from the route adjacent to the route where practical to facilitate its return to the disturbed area. Where this occurs, spread the material out rather than form windrows. Allow disturbed areas to be stabilised and natural regeneration of the native grasses to occur.</li> <li>- Construct access tracks with table drains that are free draining.</li> <li>- Avoid road crowning to allow water to naturally cross the road.</li> <li>- Form tracks to allow off-road drainage. Where track intercepts the direction of overland flow and re-directs this flow to a non-natural drainage line, install erosion control works to minimise potential erosion.</li> <li>- The design and position of erosion control measures to be determined in the field by experienced operator and site engineer, based on the site characteristics of the access track location.</li> <li>- Where construction of table drains are deemed necessary, they should have a broad flat base at least 1 m wide and should not be graded to produce a 'V' shape. To minimise erosion, the slope should be no greater than 0.5% on erodible soils or 1% on stable soils.</li> <li>- Where encounter dispersive / erosive soils they should be stabilised with gypsum or other stabiliser, as determined by laboratory analysis of soils.</li> </ul>

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Activity	Management Controls
	<ul style="list-style-type: none"> <li>- Where cut-out drains are required, they should be spaced based on the slope of the area i.e. 0.5% slope, allow for cut-out draining every 170-180 m or 1 % slope, allow for cut-out drainage every 120-130 m etc. (refer to NT Road Drainage Fact Sheet). It is noted that the recommended distance between turn-out drains is a guide and may not apply to all locations along the access track.</li> <li>- Monitor road conditions to ensure deterioration does not occur. Assist in the maintenance and repair work on roads and tracks used.</li> <li>- Following completion of activities and within 2 years after the surrender of a lease, the land surrounding or affected by the installation of access tracks shall be restored in accordance with the site-specific rehabilitation plan and final determination of asset (i.e. if transferring asset ownership to landholder).</li> </ul>
<b>Pad construction</b>	<ul style="list-style-type: none"> <li>- Pad construction to be in accordance with the typical ESCP (refer <b>Appendix E</b>). The topsoil berm dimension to be in accordance with the IECA Figure 1 Standard Drawing MB-01 presented in <b>Appendix F</b>.               <ul style="list-style-type: none"> <li>• Use topsoil berms to divert upstream runoff from undisturbed areas ('clean' water) around and away from disturbed areas, and back to the environment.</li> <li>• Use topsoil berms to contain / manage runoff from disturbed construction areas ('dirty' water) and prevent release to environment without treatment.</li> <li>• Treat runoff from construction areas through suitable sediment controls (e.g. sediment traps).</li> <li>• Configure berms so that upstream runoff does not mix with construction area runoff prior to treatment of construction area runoff.</li> </ul> </li> <li>- Where topsoil stripping is required, the stripping depth would be in accordance with Technical Instruction (NT-2050-15-TI-0001) and amelioration rates agreed with the Construction Supervisor, Origin engineers and by a suitably qualified ESC practitioner. It is noted that the expected nominal depth of topsoil across the lease pads at both locations range from &lt;100 mm to 150 mm. Final strip depth will be confirmed in the field. Any changes to the adopted ESCs will be reflected in the ESCP and to satisfaction of DENR.</li> <li>- Stockpiled felled trees nearby for future use in rehabilitation.</li> <li>- Inspect on a regular basis in accordance with Section 5 Maintenance.</li> <li>- Damage or maintenance is undertaken by an appropriately qualified person i.e. contractor / Origin.</li> <li>- Following completion of activities and within 2 years after the surrender of a lease, the land surrounding or affected by the exploration wells shall be restored in accordance with the site-specific rehabilitation plan and final determination of asset (i.e. if transferring asset ownership to landholder).</li> </ul>
<b>Stream and Creek Crossings</b>	<p>Where a crossing is required to be upgraded, a bed level crossing as detailed in <b>Appendix B</b>, will be installed in accordance with the following:</p> <ul style="list-style-type: none"> <li>- Crossings will be aligned perpendicular to the water flow.</li> <li>- Crossing will be constructed from clean rocks (minimal fine material) that are an equivalent or larger size than the natural bed material at the crossing.</li> <li>- The surface is to be left rough and not to be over compacted (e.g. track-rolled finish or rougher).</li> </ul>

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Activity	Management Controls
	<ul style="list-style-type: none"> <li>- The lowest point of the bed level crossing will be installed at the level of the lowest point of the natural stream bed (preconstruction), within the footprint of the proposed crossing.</li> <li>- There must be a height difference of at least 100 mm up to ≤ 300mm from the lowest point of the crossing to the edges of the low flow section of the crossing.</li> </ul> <p>Where scour protection is required:</p> <ul style="list-style-type: none"> <li>- Scour protection must abut the surface edge of the crossing at the same level (this is to ensure that there is no drop in elevation at the join).</li> <li>- If the crossing is set below bed level then the surface of the scour protection must also be below bed level.</li> <li>- The stream bed must abut the scour protection at the same level (this is to ensure that there is no drop in elevation at the join).</li> <li>- The scour protection is installed at a gradient no steeper than 1 in 20 or the natural channel gradient, whichever is steeper.</li> <li>- Scour protection must incorporate a low flow channel. Use clean rocks (minimal fine material), at least 100 mm diameter.</li> <li>- Ensure the rock armouring is not over compacted but left at the same level and uneven (track-rolled finish or rougher).</li> <li>- Use clean rocks (minimal fine material), at least 100 mm diameter.</li> <li>- The retention of vegetation buffers, as outlined in the NTG Land Clearing Guidelines 2019, as they relate to stream order has been considered for the siting of proposed access tracks and pads.</li> <li>- Site specific progressive ECP's should be approved by DENR prior to any disturbance.</li> <li>- Should activities pushout to the wetseason, the ESCP to be reviewed and updated for Wet Season conditions. The revision to be reviewed and approved by DENR during October to allow implementation of the plan prior to the onset of the wet season. Wet season ESCP to be implemented between 1 November to 31 March.</li> </ul>
<b>Soil and Stockpile Management</b>	<ul style="list-style-type: none"> <li>- Stockpile existing topsoil, where available, so that it can be reused on the site for ESC and future rehabilitation at completion of project.</li> <li>- Stockpiles of erodible material that has the potential to cause environmental harm if displaced, must be:               <ul style="list-style-type: none"> <li>(i) Appropriately protected from wind, rain, concentrated surface flow and excessive up-slope stormwater surface flows.</li> <li>(ii) Located at least 2m from any hazardous area or retained vegetation.</li> <li>(iii) Located up-slope of an appropriate sediment control system.</li> <li>(iv) Provided with an appropriate protective cover (synthetic or vegetative) if the materials are likely to be stockpiled for more than 28 days.</li> <li>(v) Provided with an appropriate protective cover (synthetic or vegetative) if the materials are likely to be stockpiled for more than 10 days during those months that have an erosion risk rating higher than medium.</li> </ul> </li> <li>- A suitable flow diversion system must be established immediately up-slope of a stockpile of erodible material that has the potential to cause environmental harm if displaced, if the up-slope catchment area draining to the stockpile exceeds 1,500m<sup>2</sup>.</li> </ul>

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Activity	Management Controls
	<ul style="list-style-type: none"> <li>- Avoid creating windrows. Do not create windrows across creeks, use rollers when putting in tracks in preference to dozers, or walk the dozer with the blade raised off the ground.</li> </ul>
<b>Site Management</b>	<ul style="list-style-type: none"> <li>- All disturbed areas identified as very low, low, medium or high erosion risk must be suitably stabilised prior to anticipated rainfall, from the day that soil disturbances on the area have been finalised- IECA Table 4.4.7.</li> <li>- Tracks to be regularly inspected for early signs of compaction, erosion and soil degradation (generation of bulldust). Ongoing maintenance and repair work should be implemented as required on tracks.</li> <li>- No off-lease or off-road driving.</li> <li>- The construction schedule must aim to minimise the duration that any and all areas of soil are exposed to the erosive effects of wind, rain and surface water flow.</li> <li>- Land-disturbing activities must:               <ul style="list-style-type: none"> <li>(i) allow stormwater to pass through the site in a controlled manner and at non-erosive flow velocities.</li> <li>(ii) minimise soil erosion resulting from rain, water flow and/or wind.</li> <li>(iii) minimise adverse effects of sediment runoff, including safety issues.</li> <li>(iv) prevent, or at least minimise, environmental harm resulting from work-related soil erosion and sediment runoff.</li> <li>(v) ensure that the value and use of land/properties adjacent to the site (including access roads) are not diminished as a result of the adopted ESC measures.</li> </ul> </li> <li>- Additional and/or alternative ESC measures must be implemented in the event that unacceptable off-site sedimentation is occurring as a result of the work activities.</li> <li>- Sediment deposited off the site as a direct result of an on-site activity, must be collected and the area appropriately rehabilitated as soon as reasonable and practicable, and in a manner that gives appropriate consideration to the safety and environmental risks associated with the sediment deposition.</li> </ul>
<b>Drainage Control</b>	<ul style="list-style-type: none"> <li>- Where reasonable and practicable, stormwater runoff entering the site, must be diverted around or through the area in a manner that minimises soil erosion and the contamination of water for all discharges.</li> <li>- All reasonable and practicable measures must be implemented to control flow velocities a manner that prevents soil erosion along drainage paths and at the entrance and exit of all drains and drainage pipes during storms up to the relevant design storm discharge.</li> <li>- Where reasonable and practicable, all waters discharged during construction must discharge onto stable land, in a non-erosive manner.</li> </ul>
<b>Erosion Control</b>	<ul style="list-style-type: none"> <li>- If synthetic reinforced erosion control mats or blankets are required, they must not be placed in, or adjacent to, riparian zones and watercourses if such materials are likely to cause environmental harm to wildlife or wildlife habitats.</li> </ul>

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Activity	Management Controls
	<ul style="list-style-type: none"> <li>- A minimum 60% ground cover must be achieved on all non-completed earthworks exposed to accelerated soil erosion. If further construction activities or soil disturbances are likely to be suspended for more than 30 days during months when the expected rainfall erosivity is less than 60;               <ul style="list-style-type: none"> <li>• minimum 70% cover within 30 days if between 60 and 100;</li> <li>• minimum 70% cover within 20 days if between 100 and 285;</li> <li>• minimum 80% cover within 10 days if between 285 and 1,500; and</li> <li>• minimum 95% cover within 5 days if greater than 1,500.</li> </ul> </li> </ul>
<b>Sediment Control</b>	<ul style="list-style-type: none"> <li>- Optimum benefit must be made of every opportunity to trap sediment within the work site, and as close as practicable to its source.</li> <li>- Sediment pond to be installed and operated to both collect and retain sediment (refer to Drawing NT-2050-15-MP-0021 and NT-2050-15-MP-022 in Appendix E). Design details of the sediment pond is provided in NT-2050-20-DD-0023.</li> <li>- All reasonable and practicable measures must be taken to prevent, or at least minimise, the release of sediment from the site.</li> <li>- Sediment control devices must be de-silted and made fully operational as soon as reasonable and practicable after a sediment-producing event, if the device's sediment retention capacity falls below 75% of its design retention capacity.</li> <li>- Materials removed from sediment control devices must be disposed of in a manner that does not cause ongoing soil erosion or environmental harm.</li> </ul>
<b>Site Rehabilitation</b>	<ul style="list-style-type: none"> <li>- Following completion of works, disturbed areas are to be restored and/or rehabilitated.</li> <li>- Gravel pits to have topsoil returned and re-profiled.</li> <li>- All compacted areas will be ripped and scarified to promote regeneration of vegetation, this may require assistance through spread of native seed stock.</li> <li>- All disturbed areas will be allowed to naturally regenerate or be revegetated on completion of use.</li> <li>- Compacted areas will be contour ripped to 0.5m depth where practicable.</li> <li>- At completion of activities, establish vegetation similar to adjacent vegetation, unless agreement with landowner for alternative use.</li> <li>- All disturbed areas identified as very low, low, medium or high erosion risk must be suitably stabilised prior to anticipated rainfall, from the day that soil disturbances on the area have been finalised- IECA Table 4.4.7.</li> <li>- Stabilise disturbed areas quickly to reduce the potential for erosion. Methods of stabilisation will be site specific and based, in part, on laboratory analysis of soils for erosive and dispersive characteristics.</li> <li>- Previously removed vegetation and topsoil will be uniformly re-spread over disturbed area to assist with rehabilitation process through agencies of increased infiltration and return of seed-bearing topsoil. If required, additional native seed mix from the area could be respread to speed up rehabilitation process</li> <li>- Windrows of debris that cannot be removed should be aligned down the contour or in a manner appropriate to avoid channelling and concentrating runoff. All other windrows are to be removed as soon as practicable.</li> </ul>

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Activity	Management Controls
	- The type of ground cover applied to completed earthworks is compatible with the anticipated long-term land use, environmental risk, and site rehabilitation measures.

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## 8. Monitoring

### 8.1 Construction

Monitoring for soil erosion and related issues is best undertaken at critical stages, such as:

- During siting of access tracks and exploration areas, this is when there is the greatest opportunity to avoid erosion problems.
- After completion of a specific phase of activity, all disturbed areas will be monitored before and after the wet season.
- When accessing the site after the wet season, all disturbed areas should be inspected for signs of erosion. If significant impacts are identified remediation works may need to be conducted prior to continued vehicular access.
- In the unlikely event that water is required to be released from the sediment pond, the stored water will be visually assessed (no sheen, or turbidity) and physical parameters (pH, EC) taken to ensure release water will not impact on any downgradient sensitive receiving environments. It is noted that at both lease area there is no sensitive receiving water bodies located within 10-15 km from the sites.

### 8.2 Operations

Inspections of all disturbed areas is required before and after the wet season to identify the occurrence of erosion and sedimentation. Where erosion is observed, maintenance activities shall be undertaken. Ongoing Monitoring and maintenance shall occur throughout the life of the infrastructure until the land is handed back.

### 8.3 Rehabilitation

Where rehabilitation of a site is required, rehabilitation monitoring will be undertaken annually to assess the rehabilitation success and determine whether additional remedial works are required. Success criteria are defined in the relevant EMP and include:

- Safe for humans and wildlife
- Non-polluting
- Stable, with appropriate vegetation cover
- Land condition suitable for existing pastoral land use.

### 8.4 Incident Reporting

The Constructor must follow incident reporting requirements covered in the Origin Incident Management Directive.

Sediment release and turbidity increase incidents can require some assessment to determine if they are reportable, as controls are only designed to cope with certain rain events (refer to IECA, 2008).

The Constructor must:

- Report sediment release and turbidity increase incidents.
- Include justification in each case of why the incident is, or is not, reportable to the regulator based on:
  - The state of the controls prior to the rainfall
  - The design standard applied (IECA, 2008)

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- The actual rainfall received, based on the nearest data source available
- Whether the design storm event was exceeded or not; and
- Whether environmental harm was caused or not.

## 8.5 Records

Records shall be retained demonstrating area have been inspected. Photographic records will be maintained over the duration of the activities for documenting soil disturbance.

All environmentally relevant incidents are to be recorded in a field log that must remain accessible to all relevant regulatory authorities.

## 8.6 ESCP Revisions

Where major changes are required to the proposed controls in the ESCP, DENR would be advised and revised Secondary ESCP provided for review and approval. In particular, should construction activities progress into the Wet Season, the ESCP will be updated during October and implemented between 1st November and maintained in place until 31st March.

Refer to the ESCP checklist (**Appendix J**) to determine where additional ESC requirements may be required.

## 8.7 Maintenance

All temporary erosion and sediment control measures, including drainage control measures, must be fully operational and maintained in proper working order at all times during the project.

When undertaking construction work, erosion and sediment control measures must be inspected:

- at least daily (when work is occurring on-site)
- within 24 hours of expected rainfall
- within 18 hours of a rainfall event of sufficient intensity and duration to cause runoff on-site or greater than 20mm in 24 hours.

Once operational, inspections of the site will continue daily while onsite, and before and after the wetseason. Where erosion is observed, maintenance activities shall be undertaken.

Sediment removed from sediment traps and places of sediment deposition must be disposed of in a lawful manner that does not cause ongoing soil erosion or environmental harm.

Prior to the completion of activities on the ground, the construction areas will be stabilised to the satisfaction of the Construction Supervisor.

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## Appendix A Erosion Hazard Assessment Explanatory Notes

reference: IECA, 2008, *Best Practice Erosion and Sediment Control Hazard Assessment Form*)

**Requirements:** Specific issues or actions required by the proponent.

**Warnings:** Issues that should be considered by the proponent.

**Comments:** General information relating to the topic.

### [1] REQUIREMENTS:

For sites with an average slope of proposed land disturbance greater than 10%, a preliminary ESCP must be submitted to the regulatory authority for approval during planning negotiations.

Proponents must demonstrate that adequate erosion and sediment control measures can be implemented on-site to effectively protect downstream environmental values.

If site or financial constraints suggest that it is not reasonable or practicable for the prescribed water quality objectives to be achieved for the proposal, then the proponent must demonstrate that alternative designs or construction techniques (e.g. pole homes, suspended slab) cannot reasonably be implemented on the site.

### WARNINGS:

Steep sites usually require more stringent drainage and erosion controls than flatter grade sites.

### COMMENTS:

The steeper the land, the greater the need for adequate drainage controls to prevent soil and mulch from being washed from the site.

### [2] REQUIREMENTS:

If the actual soil K-factor is known from soil testing, then the Score shall be determined from Table 1.

If a preliminary ESCP is required during planning negotiations, then it must be demonstrated that adequate space is available for the construction and operation of any major sediment traps, including the provision for any sediment basins and their associated embankments and spillways. It must also be demonstrated that all reasonable and practicable measures can be taken to divert the maximum quantity of sediment-laden runoff (up to the specified design storm) to these sediment traps throughout the construction phase and until the contributing catchment is adequately stabilised against erosion.

### WARNINGS:-

The higher the point score, the greater the need to protect the soil from raindrop impact and thus the greater the need for effective erosion control measures. A point score of 2 or greater will require a greater emphasis to be placed on revegetation techniques that do not expose the soil to direct rainfall contact during vegetation establishment, e.g. turfing and *Hydromulching*.

### COMMENTS:

Table 2 provides an *indication* of soil conditions likely to be associated with a particular Soil group based on a statistical analysis of soil testing across NSW. This table provides only an initial estimate of the likely soil conditions.

The left-hand-side of the table provides an indication of the type of sediment basin that will be required (Type C, F or D). The right-hand-side of the table provides an indication of the likely erodibility of the soil based on the Revised Universal Soil Loss Equation (RUSLE) K-factor.

Table 3 provides some general comments on the erosion potential of the various soil groups.

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Table 1 – Score if soil K-factor is known

	RUSLE soil erodibility K-factor			
	K < 0.02	0.02<K<0.04	0.04<K<0.06	K > 0.06
Score	0	1	2	3

Table 2 – Statistical analysis of NSW soil data [1]

Unified Soil Class System	Likely sediment basin classification (%)			Probable soil erodibility K-factor (%) [2]			
	Dry	Wet		Low	Moderate	High	Very High
	Type C	Type F	Type D	K < 0.02	0.02<K<0.04	0.04<K<0.06	K > 0.06
GM	30	58	12	12	51	26	12
GC	42	33	25	13	71	17	0
SW	40	48	12	49	39	12	0
SP	53	32	15	76	18	5	1
SM	21	67	12	26	48	25	1
SC	26	50	24	16	64	18	2
ML	5	63	32	4	35	45	16
CL	9	51	39	12	56	19	13
OL	2	80	18	34	61	5	1
MH	12	41	48	15	19	41	25
CH	5	44	51	39	43	11	7

Notes: [1] Analysis of soil data presented in Landcom (2004).

[2] Soil erodibility based on Revised Universal Soil Loss Equation (RUSLE) K-factor.

## Unified Soil Classification System (USCS)

GW Well graded gravels, gravel-sand mixtures, little or no fines

GP Poorly graded gravels, gravel-sand mixture, little or no fines

GM Silty gravels, poorly graded gravel-sand-silt mixtures

GC Clayey gravels, poorly graded gravel-sand-clay mixtures

SW Well graded sands, gravelly sands, little or no fines

SP Poorly graded sands, gravelly sands, little or no fines

SM Silty sands, poorly graded sand-silt mixtures

SC Clayey sands, poorly graded sand-clay mixtures

ML Inorganic silts & very fine sands, rock flour, silty or clayey fine sands with slight plasticity

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- CL Inorganic clays, low–medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
- OL Organic silts and organic silt-clays of low plasticity
- MH Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
- CH Inorganic clays of high plasticity, fat clays
- OH Organic clays of medium to high plasticity

**Table 3 – Typical properties of various soil groups<sup>[1]</sup>**

Soil Groups	Typical properties <sup>[2]</sup>
GW, GP	<ul style="list-style-type: none"> <li>• Low erodibility potential.</li> </ul>
GM, GC	<ul style="list-style-type: none"> <li>• Low to medium erodibility potential.</li> <li>• May create turbid runoff if disturbed as a result of the release of silt and clay particles.</li> </ul>
SW, SP	<ul style="list-style-type: none"> <li>• Low to medium erodibility potential.</li> </ul>
SM, SC	<ul style="list-style-type: none"> <li>• Medium erodibility potential.</li> <li>• May create turbid runoff if disturbed as a result of the release of silt and clay particles.</li> </ul>
MH, CH	<ul style="list-style-type: none"> <li>• Highly variable (low to high) erodibility potential.</li> <li>• Will generally create turbid runoff if disturbed.</li> </ul>
ML, CL	<ul style="list-style-type: none"> <li>• High erodibility potential.</li> <li>• Tendency to be dispersive.</li> <li>• May create some turbidity in runoff if disturbed.</li> </ul>

Note: [1] After Soil Services & NSW DLWC (1998).

[2] Any soil can represent a high erosion risk if the binding clays or silts are unstable.

Table 4 provides **general** guidelines on the suitability of various soil groups to various engineering applications.

**Table 4 – Engineering suitability based on Unified Soil Classification<sup>[1]</sup>**

Unified Soil Class	USC Group	Embankments		Fill	Slope stability	Untreated roads
		Water retaining	Non-water retaining			
Well graded gravels	GW	Unsuitable	Excellent	Excellent	Excellent	Average
Poorly graded gravel	GP	Unsuitable	Average	Excellent	Average	Unsuitable
Silty gravels	GM	Unsuitable	Average	Good	Average	Average
Clayey gravels	GC	Suitable	Average	Good	Average	Excellent
Well graded sands	SW	Unsuitable	Excellent	Excellent	Excellent	Average
Poorly graded sands	SP	Unsuitable	Average	Good	Average	Unsuitable
Silty sands	SM	Suitable <sup>[2]</sup>	Average	Average	Average	Poor
Clayey sands	SC	Suitable	Average	Average	Average	Good
Inorganic silts	ML	Unsuitable	Poor	Average	Poor	Unsuitable
Inorganic clays	CL	Suitable <sup>[2]</sup>	Good	Average	Good	Poor

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Organic silts	OL	Unsuitable	Unsuitable	Poor	Unsuitable	Unsuitable
Inorganic silts	MH	Unsuitable	Poor	Poor	Poor	Unsuitable
Inorganic clays	CH	Suitable <sup>[2]</sup>	Average	Unsuitable	Average	Unsuitable
Organic clays	OH	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable
Highly organic soils	Pt	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable

Notes: [1] Modified from Hazelton & Murphy (1992)

[2] Suitable only after modifications to soil such as compaction and/or erosion protection

[3] If the soils have not been tested for Emerson Class, then adopt a score of 4.

## REQUIREMENTS:

Works proposed on sites containing Emerson Class 1 or 2 soils have a very high pollution potential and must submit a conceptual ESCP to the regulatory authority for review and/or approval (as required by the authority) during planning negotiations.

## WARNINGS:

Class 3 and 5 soils disturbed by cut and fill operations or construction traffic are highly likely to discolour stormwater (i.e. cause turbid runoff). Chemical stabilisation will likely be required if these soils are placed immediately adjacent to a retaining wall. Any disturbed Class 1, 2, 3 and 5 soils that are to be revegetated must be covered with a non-dispersive topsoil as soon as possible (unless otherwise agreed by the regulatory authority).

Class 1 and 2 soils are highly likely to discolour (pollute) stormwater if exposed to rainfall or flowing water. Treatment of these soils with gypsum (or other suitable substance) will most likely be required. These soils should not be placed directly behind a retaining wall unless it has been adequately treated (stabilised) or covered with a non-dispersible soil.

[4] The duration of disturbance refers to the total duration of soil exposure to rainfall up until a time when there is at least 70% coverage of all areas of soil.

## REQUIREMENTS:

All land developments with an expected soil disturbance period greater than 6 months must submit a conceptual ESCP to the regulatory authority for review and/or approval (as required by the authority) during planning negotiations.

## COMMENTS:

Construction periods greater than 3 months will generally experience at least some significant storm events, independent of the time of year that the construction (soil disturbance) occurs.

[5] **REQUIREMENTS:**

Development proposals with an expected soil disturbance in excess of 1ha must submit a conceptual ESCP to the regulatory authority for review and/or approval (as required by the regulatory authority) during planning negotiations.

The area of disturbance refers to the total area of soil exposed to rainfall or dust-producing winds either as a result of:

- (a) the removal of ground cover vegetation, mulch or sealed surfaces;
- (b) past land management practices;
- (c) natural conditions.

## WARNINGS:

A *Sediment Basin* will usually be required if the disturbed area exceeds 0.25ha (2500m<sup>2</sup>) within any sub-catchment (i.e. land flowing to one outlet point).

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## COMMENTS:

For soil disturbances greater than 0.25ha, the revegetation phase should be staged to minimise the duration for which soils are exposed to wind, rain and concentrated runoff.

### [6] REQUIREMENTS:

All developments that involve earthworks or construction within a natural watercourse (whether that watercourse is in a natural or modified condition) must submit a conceptual ESCP to the regulatory authority for review and/or approval (as required by the regulatory authority) during planning negotiations.

Permits and/or licences may be required from the State Government, including possible submission of the ESCP to the relevant Government department.

### [7] REQUIREMENTS:

No areas of soil disturbance shall be left exposed to rainfall or dust-producing winds at the end of a development without an adequate degree of protection and/or an appropriate action plan for the establishment of at least 70% cover.

## COMMENTS:

Grass seeding without the application of a light mulch cover is considered the least favourable revegetation technique. A light mulch cover is required to protect the soil from raindrop impact, excessive temperature fluctuations, and the loss of essential soil moisture.

### [8] COMMENTS:

All receiving waters can be adversely affected by unnatural quantities of sediment-laden runoff. Freshwater ecosystems are generally more susceptible to ecological harm resulting from the inflow of fine or dispersible clays than saline water bodies. The further inland a land disturbance is, the greater the potential for the released sediment to cause environmental harm as this sediment travels towards the coast.

For the purpose of this clause it is assumed that all sediment-laden runoff will eventually flow into saline waters. Thus, sediment-laden discharges that flow first into freshwater are likely to adversely affect both fresh and saline water bodies and are therefore considered potentially more damaging to the environment.

This clause does **not** imply that sediment-laden runoff will not cause harm to saline waters.

### [9] COMMENTS:

This clause refers to subsoils exposed during the construction phase either as a result of past land practices or proposed construction activities. The exposure of subsoils resulting from the excavation of minor service trenches should not be considered.

### [10] WARNINGS:

The greater the extent of external catchment, the greater the need to divert up-slope stormwater runoff around any soil disturbance.

## COMMENTS:

The ability to separate “clean” (i.e. external catchment) stormwater runoff from “dirty” site runoff can have a significant effect on the size, efficiency and cost of the temporary drainage, erosion, and sediment control measures.

### [11] REQUIREMENTS:

Permission must be obtained from the owner of a road reserve before placing any erosion and sediment control measures within the road reserve.

## WARNINGS:

Few sediment control techniques work efficiently when placed on a road and/or around roadside stormwater inlets. Great care must be taken if sediment control measures are located on a public roadway, specifically:

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- safety issues relating to road users;
- the risk of causing flooding on the road or within private property.

The construction of roads (whether temporary or permanent) will usually modify the flow path of stormwater runoff. This can affect how “dirty” site runoff is directed to the sediment control measures.

## COMMENTS:

“On-road” sediment control devices are at best viewed as secondary or supplementary sediment control measures. Only in special cases and/or on very small projects (e.g. kerb and channel replacement) might these controls be considered as the “primary” sediment control measure.

## [12] WARNINGS:

Soils with a pH less than 5.5 or greater than 8 will usually require treatment in order to achieve satisfactory revegetation. Soils with a pH of less than 5 (whether naturally acidic or in acid sulfate soil areas) may also limit the choice of chemical flocculants (e.g. Alum) for use in the flocculation of *Sediment Basins*.

## [13] REQUIREMENTS:

A preliminary ESCP must be submitted to the local government for approval during the planning phase for any development that obtains a total point score of 17 or greater or when any trigger value is scored or exceeded.

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## Appendix B Lease Pad and Stuart Highway Topographical Survey



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	<p><b>SETOUT AND DETAIL SURVEY</b></p> <p>Client: <b>AECOM AUSTRALIA PTY LTD</b></p>	<p>Drawn by: NM Date: 14/02/2019 Cad File: 10864-3.DWG</p>	<p>Drawing No: <b>19/10964/3</b></p>

Review due: 05/11/2021

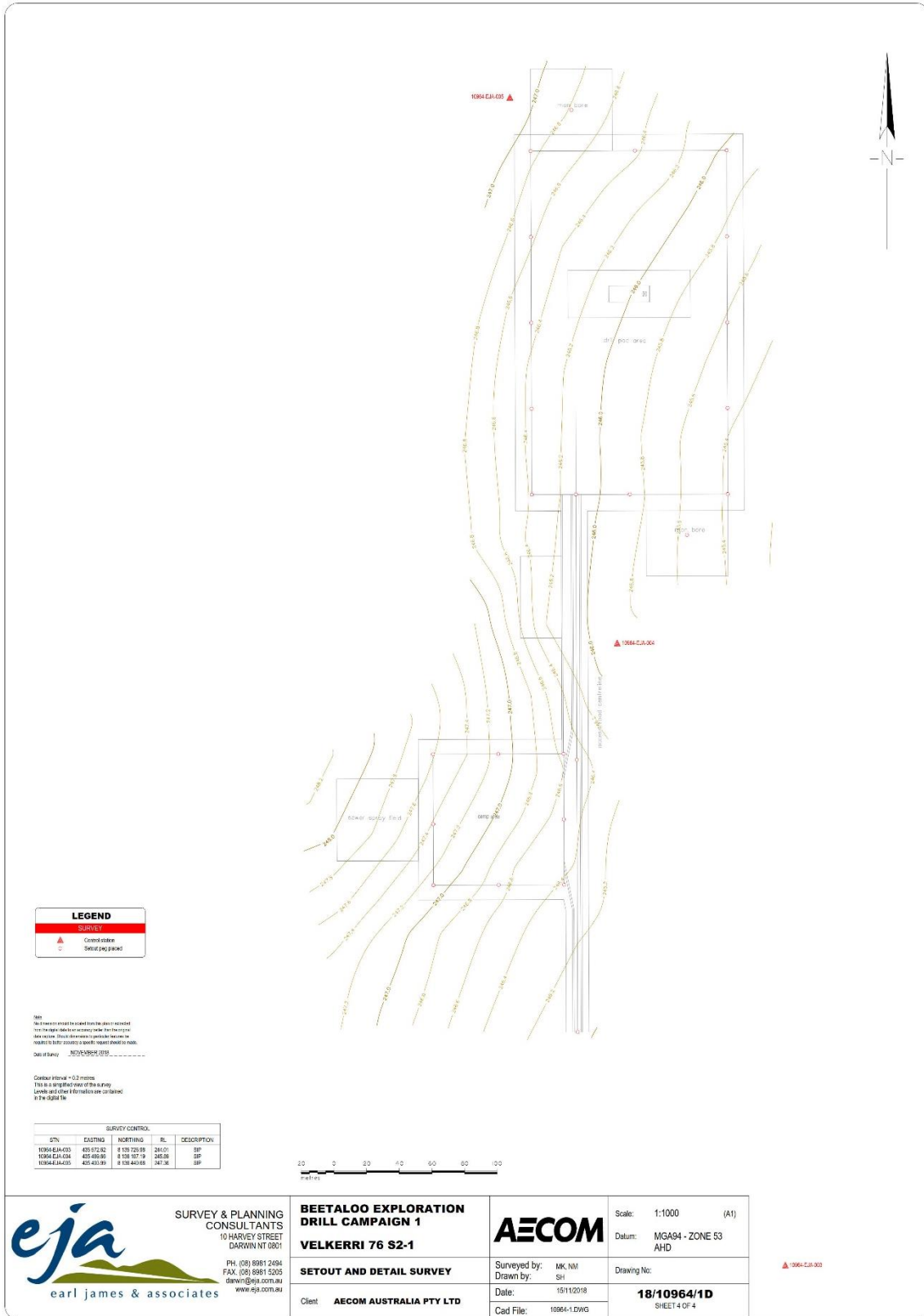
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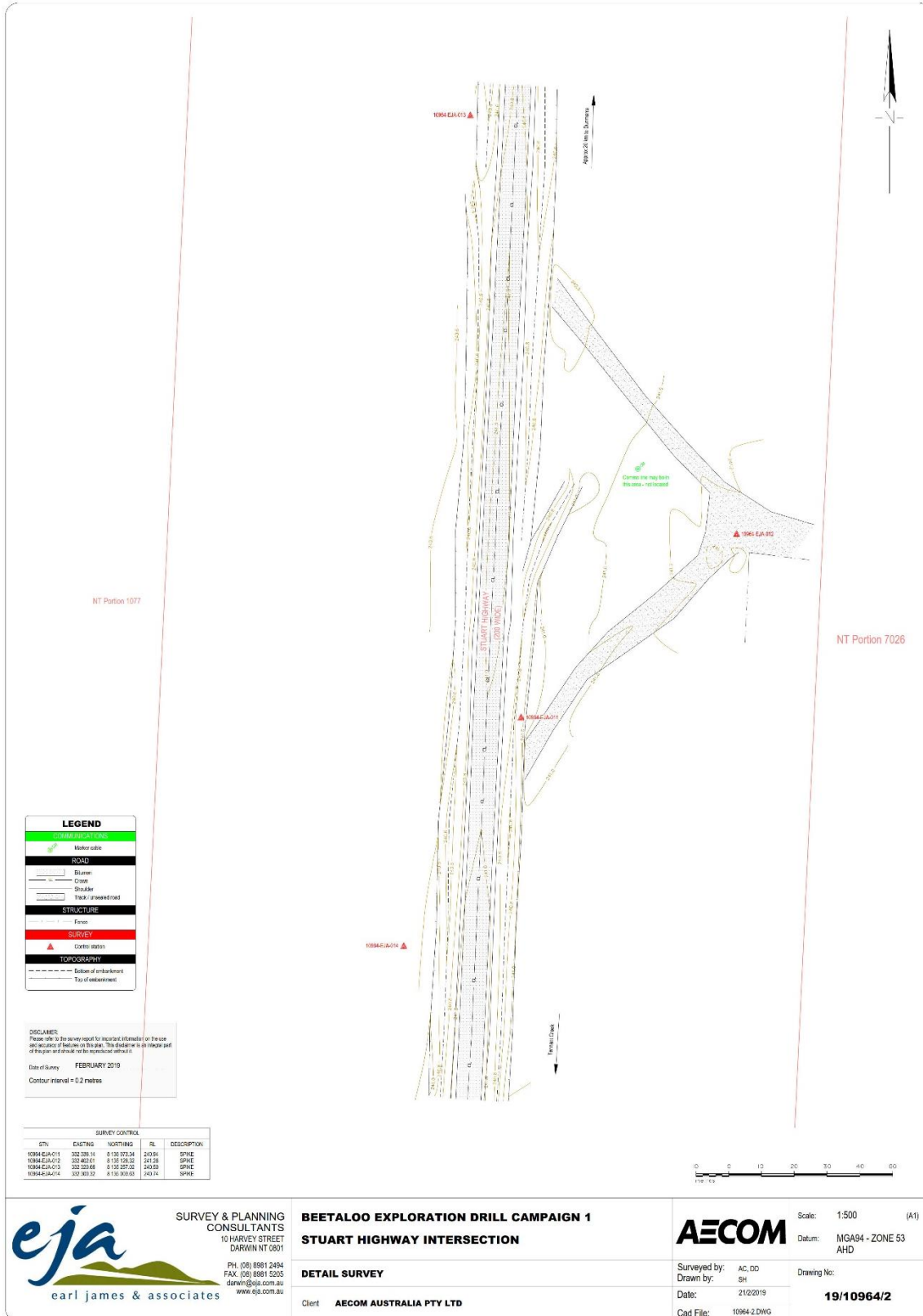
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# Primary Erosion and Sediment Control Plan

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**LEGEND**

- 10964 PROJECT ROAD
- Marker cable
- ROAD**
  - Blumen
  - Crest
  - Shoulder
  - Track / crushed rock
- STRUCTURE**
  - Fence
- SURVEY**
  - Control station
- TOPOGRAPHY**
  - Bottom of embankment
  - Top of embankment

**DISCLAIMER**  
 Please refer to the survey report for important information on the use and accuracy of features on this plan. This disclaimer is an integral part of the plan and should be read in conjunction with it.  
 Date of survey: **FEBRUARY 2019**  
 Contour interval = 0.2 metres

SURVEY CONTROL				
IDN	EASTING	NORTHING	RL	DESCRIPTION
10964-EJA-011	332 338.11	8 138 373.34	249.66	SPIKE
10964-EJA-012	332 462.01	8 138 126.32	241.28	SPIKE
10964-EJA-013	332 329.69	8 138 387.26	249.29	SPIKE
10964-EJA-014	332 303.32	8 138 309.68	249.14	SPIKE

**eja**  
 earl james & associates  
 SURVEY & PLANNING CONSULTANTS  
 10 HARVEY STREET  
 DARWIN NT 0801  
 PH: (08) 8981 2494  
 FAX: (08) 8981 5205  
 darwin@eja.com.au  
 www.eja.com.au

**BEETALOO EXPLORATION DRILL CAMPAIGN 1**  
**STUART HIGHWAY INTERSECTION**  
**DETAIL SURVEY**  
 Client: **AECOM AUSTRALIA PTY LTD**

**AECOM**  
 Scale: 1:500 (A1)  
 Datum: MGA94 - ZONE 53 AHD  
 Surveyed by: AC, DD  
 Drawn by: SH  
 Date: 21/02/2019  
 Cad File: 10964.2.DWG  
 Drawing No: **19/10964/2**

Review due: 05/11/2021

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## Appendix C Geotechnical Laboratory Results

### Material Test Report

**Report Number:** 677612.00-1  
**Issue Number:** 2 - This version supersedes all previous issues  
**Date Issued:** 29/01/2019  
**Client:** AECOM Australia Pty Ltd  
 PO Box 73, Hunter Region NSW 2310  
**Contact:** Jace Emberg  
**Project Number:** 677612.00  
**Project Name:** 60480548 - Beetaloo soil samples  
**Project Location:** Beetaloo, NT  
**Work Request:** 1466  
**Sample Number:** 19-1466F  
**Date Sampled:** 13/12/2018  
**Sampling Method:** AS1289 1.2.1.6.4 - Sampling from layers in earthworks or pavement - uncompact/compacted  
**Sample Location:** KYALLA01 (0.0 - 0.4m)  
**Material:** SAND, with silt

Sieve	Passed %	Passing Limits
19 mm	100	
13.2 mm	100	
9.5 mm	100	
5.7 mm	100	
4.75 mm	100	
2.36 mm	100	
1.18 mm	99	
0.6 mm	93	
0.425 mm	76	
0.3 mm	52	
0.15 mm	24	
0.075 mm	16	

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)	Min	Max
Sample History	Air Dried	
Preparation Method	Dry Sieve	
Liquid Limit (%)	Not Obtainable	
Plastic Limit (%)	Not Obtainable	
Plasticity Index (%)	Non Plastic	

Linear Shrinkage (AS1289 3.4.1)	Min	Max
Linear Shrinkage (%)	0.0	
Cracking Crumbling Curling	None	

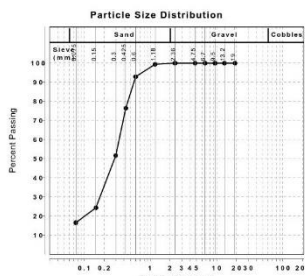
  

Moisture Content (AS 1289 2.1.1)	Min	Max
Moisture Content (%)		1.9

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**NATA**  
 ACCREDITED

Approved Signatory: Dave Millard  
 Engineering Geologist  
 NATA Accredited Laboratory Number: 828



### Material Test Report

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**Project Number:** 677612.00  
**Project Name:** 60480548 - Beetaloo soil samples  
**Project Location:** Beetaloo, NT  
**Work Request:** 1466  
**Sample Number:** 19-1466G  
**Date Sampled:** 13/12/2018  
**Sampling Method:** AS1289 1.2.1.6.4 - Sampling from layers in earthworks or pavement - uncompact/compacted  
**Sample Location:** KYALLA02 (0.0 - 0.4m)  
**Material:** Silty SAND

Sieve	Passed %	Passing Limits
19 mm	100	
13.2 mm	100	
9.5 mm	100	
6.7 mm	100	
4.75 mm	100	
2.36 mm	100	
1.18 mm	99	
0.6 mm	96	
0.425 mm	89	
0.3 mm	71	
0.15 mm	33	
0.075 mm	19	

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)	Min	Max
Sample History	Air Dried	
Preparation Method	Dry Sieve	
Liquid Limit (%)	14	
Plastic Limit (%)	13	
Plasticity Index (%)	1	

Linear Shrinkage (AS1289 3.4.1)	Min	Max
Linear Shrinkage (%)	0.0	
Cracking Crumbling Curling	Cracking	

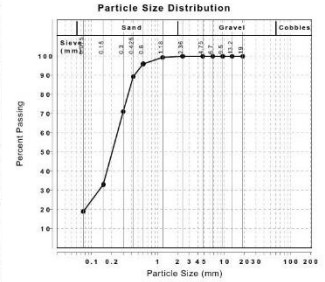
  

Moisture Content (AS 1289 2.1.1)	Min	Max
Moisture Content (%)		2.3

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**Contact:** Jace Emberg  
**Project Number:** 677612.00  
**Project Name:** 60480548 - Beetaloo soil samples  
**Project Location:** Beetaloo, NT  
**Work Request:** 1466  
**Sample Number:** 19-1466H  
**Date Sampled:** 13/12/2018  
**Sampling Method:** AS1289 1.2.1.6.4 - Sampling from layers in earthworks or pavement - uncompact/compacted  
**Sample Location:** KYALLA03 (0.0 - 0.4m)  
**Material:** Silty SAND

Sieve	Passed %	Passing Limits
19 mm	100	
13.2 mm	100	
9.5 mm	100	
6.7 mm	100	
4.75 mm	100	
2.36 mm	100	
1.18 mm	99	
0.6 mm	93	
0.425 mm	81	
0.3 mm	60	
0.15 mm	32	
0.075 mm	22	

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)	Min	Max
Sample History	Air Dried	
Preparation Method	Dry Sieve	
Liquid Limit (%)	15	
Plastic Limit (%)	13	
Plasticity Index (%)	2	

Linear Shrinkage (AS1289 3.4.1)	Min	Max
Linear Shrinkage (%)	1.0	
Cracking Crumbling Curling	Cracking	

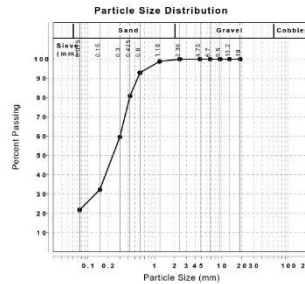
  

Moisture Content (AS 1289 2.1.1)	Min	Max
Moisture Content (%)		3.1

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**Project Number:** 677612.00  
**Project Name:** 60480548 - Beetaloo soil samples  
**Project Location:** Beetaloo, NT  
**Work Request:** 1466  
**Sample Number:** 19-1466I  
**Date Sampled:** 13/12/2018  
**Sampling Method:** AS1289 1.2.1.6.4 - Sampling from layers in earthworks or pavement - uncompact/compacted  
**Sample Location:** KYALLA04 (0.0 - 0.4m)  
**Material:** Silty SAND

Sieve	Passed %	Passing Limits
19 mm	100	
13.2 mm	100	
9.5 mm	100	
6.7 mm	100	
4.75 mm	100	
2.36 mm	100	
1.18 mm	99	
0.6 mm	91	
0.425 mm	77	
0.3 mm	55	
0.15 mm	27	
0.075 mm	17	

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)	Min	Max
Sample History	Oven Dried / Air Dried / Natural	
Preparation Method	Wet Sieve / Dry Sieve / Both Sieves	
Liquid Limit (%)	15	
Plastic Limit (%)	13	
Plasticity Index (%)	2	

Linear Shrinkage (AS1289 3.4.1)	Min	Max
Linear Shrinkage (%)	0.5	
Cracking Crumbling Curling	Cracking	

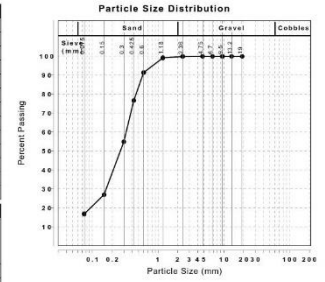
  

Moisture Content (AS 1289 2.1.1)	Min	Max
Moisture Content (%)		2.0

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 Accredited for compliance with ISO/IEC 17025 - Testing

**NATA**  
 ACCREDITED

Approved Signatory: Dave Millard  
 Engineering Geologist  
 NATA Accredited Laboratory Number: 828



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# Primary Erosion and Sediment Control Plan

NT-2050-15-MP-019.

## Material Test Report

**Report Number:** 677612.00-1  
**Issue Number:** 2 - This version supersedes all previous issues  
**Date Issued:** 29/01/2019  
**Client:** AECOM Australia Pty Ltd  
 PO Box 73, Hunter Region NSW 2310  
**Contact:** Jaco Emborg  
**Project Number:** 677612.00  
**Project Name:** 60480548 - Beetaloo soil samples  
**Project Location:** Beetaloo, NT  
**Work Request:** 1466  
**Sample Number:** 19-1466A  
**Date Sampled:** 13/12/2018  
**Sampling Method:** AS 1289 1.2.1 6.4 - Sampling from layers in earthworks or pavement - uncompacted/compacted  
**Sample Location:** VELKERR01 (0.0 - 0.4m)  
**Material:** Silty SAND, trace gravel



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 Approved Signatory: Dave Millard  
 Engineering Geologist  
 NATA Accredited Laboratory Number: 828

Particle Distribution (AS1289 3.6.1)		
Sieve	Passed %	Passing Limits
19 mm	100	
13.2 mm	100	
9.5 mm	100	
6.7 mm	99	
4.75 mm	98	
2.36 mm	96	
1.18 mm	90	
0.6 mm	78	
0.425 mm	67	
0.3 mm	54	
0.15 mm	35	
0.075 mm	29	

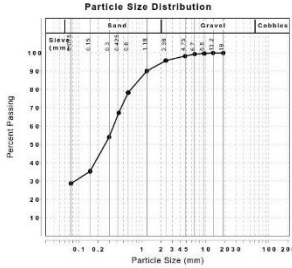
Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		
Sample History	Air Dried	Min
Preparation Method	Dry Sieve	Max
Liquid Limit (%)	25	
Plastic Limit (%)	15	
Plasticity Index (%)	10	

Linear Shrinkage (AS1289 3.4.1)		
Linear Shrinkage (%)	4.5	Min
Cracking Crumbling Curling	Cracking	Max

Moisture Content (AS 1289 2.1.1)		
Moisture Content (%)	8.6	



## Material Test Report

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**Date Issued:** 29/01/2019  
**Client:** AECOM Australia Pty Ltd  
 PO Box 73, Hunter Region NSW 2310  
**Contact:** Jaco Emborg  
**Project Number:** 677612.00  
**Project Name:** 60480548 - Beetaloo soil samples  
**Project Location:** Beetaloo, NT  
**Work Request:** 1466  
**Sample Number:** 19-1466B  
**Date Sampled:** 13/12/2018  
**Sampling Method:** AS 1289 1.2.1 6.4 - Sampling from layers in earthworks or pavement - uncompacted/compacted  
**Sample Location:** VELKERR02 (0.0 - 0.4m)  
**Material:** Silty SAND



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 Engineering Geologist  
 NATA Accredited Laboratory Number: 828

Particle Distribution (AS1289 3.6.1)		
Sieve	Passed %	Passing Limits
19 mm	100	
13.2 mm	100	
9.5 mm	100	
6.7 mm	100	
4.75 mm	99	
2.36 mm	97	
1.18 mm	94	
0.6 mm	81	
0.425 mm	68	
0.3 mm	58	
0.15 mm	50	
0.075 mm	41	

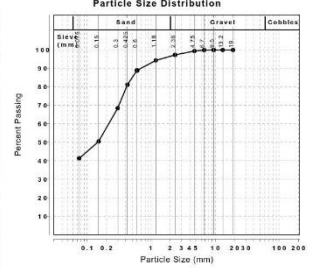
Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		
Sample History	Air Dried	Min
Preparation Method	Dry Sieve	Max
Liquid Limit (%)	18	
Plastic Limit (%)	13	
Plasticity Index (%)	5	

Linear Shrinkage (AS1289 3.4.1)		
Linear Shrinkage (%)	3.5	Min
Cracking Crumbling Curling	Cracking	Max

Moisture Content (AS 1289 2.1.1)		
Moisture Content (%)	5.6	



## Material Test Report

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**Date Issued:** 29/01/2019  
**Client:** AECOM Australia Pty Ltd  
 PO Box 73, Hunter Region NSW 2310  
**Contact:** Jaco Emborg  
**Project Number:** 677612.00  
**Project Name:** 60480548 - Beetaloo soil samples  
**Project Location:** Beetaloo, NT  
**Work Request:** 1466  
**Sample Number:** 19-1466C  
**Date Sampled:** 13/12/2018  
**Sampling Method:** AS 1289 1.2.1 6.4 - Sampling from layers in earthworks or pavement - uncompacted/compacted  
**Sample Location:** VELKERR03 (0.0 - 0.4m)  
**Material:** Silty SAND



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 Approved Signatory: Dave Millard  
 Engineering Geologist  
 NATA Accredited Laboratory Number: 828

Particle Distribution (AS1289 3.6.1)		
Sieve	Passed %	Passing Limits
19 mm	100	
13.2 mm	100	
9.5 mm	100	
6.7 mm	100	
4.75 mm	100	
2.36 mm	99	
1.18 mm	96	
0.6 mm	92	
0.425 mm	88	
0.3 mm	76	
0.15 mm	54	
0.075 mm	41	

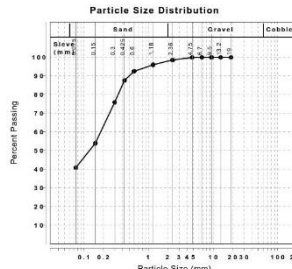
Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		
Sample History	Air Dried	Min
Preparation Method	Dry Sieve	Max
Liquid Limit (%)	19	
Plastic Limit (%)	12	
Plasticity Index (%)	7	

Linear Shrinkage (AS1289 3.4.1)		
Linear Shrinkage (%)	3.5	Min
Cracking Crumbling Curling	Cracking	Max

Moisture Content (AS 1289 2.1.1)		
Moisture Content (%)	4.9	



## Material Test Report

**Report Number:** 677612.00-1  
**Issue Number:** 2 - This version supersedes all previous issues  
**Date Issued:** 29/01/2019  
**Client:** AECOM Australia Pty Ltd  
 PO Box 73, Hunter Region NSW 2310  
**Contact:** Jaco Emborg  
**Project Number:** 677612.00  
**Project Name:** 60480548 - Beetaloo soil samples  
**Project Location:** Beetaloo, NT  
**Work Request:** 1466  
**Sample Number:** 19-1466D  
**Date Sampled:** 13/12/2018  
**Sampling Method:** AS 1289 1.2.1 6.4 - Sampling from layers in earthworks or pavement - uncompacted/compacted  
**Sample Location:** VELKERR04 (0.0 - 0.4m)  
**Material:** Silty SAND



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 Accredited for compliance with ISO/IEC 17025 - Testing  
 Approved Signatory: Dave Millard  
 Engineering Geologist  
 NATA Accredited Laboratory Number: 828

Particle Distribution (AS1289 3.6.1)		
Sieve	Passed %	Passing Limits
19 mm	100	
13.2 mm	100	
9.5 mm	100	
6.7 mm	100	
4.75 mm	100	
2.36 mm	99	
1.18 mm	97	
0.6 mm	91	
0.425 mm	84	
0.3 mm	72	
0.15 mm	54	
0.075 mm	46	

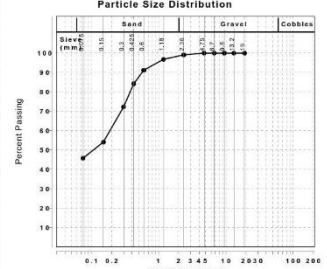
Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		
Sample History	Air Dried	Min
Preparation Method	Dry Sieve	Max
Liquid Limit (%)	24	
Plastic Limit (%)	13	
Plasticity Index (%)	11	

Linear Shrinkage (AS1289 3.4.1)		
Linear Shrinkage (%)	4.5	Min
Cracking Crumbling Curling	Cracking	Max

Moisture Content (AS 1289 2.1.1)		
Moisture Content (%)	5.2	



Review due: 05/11/2021

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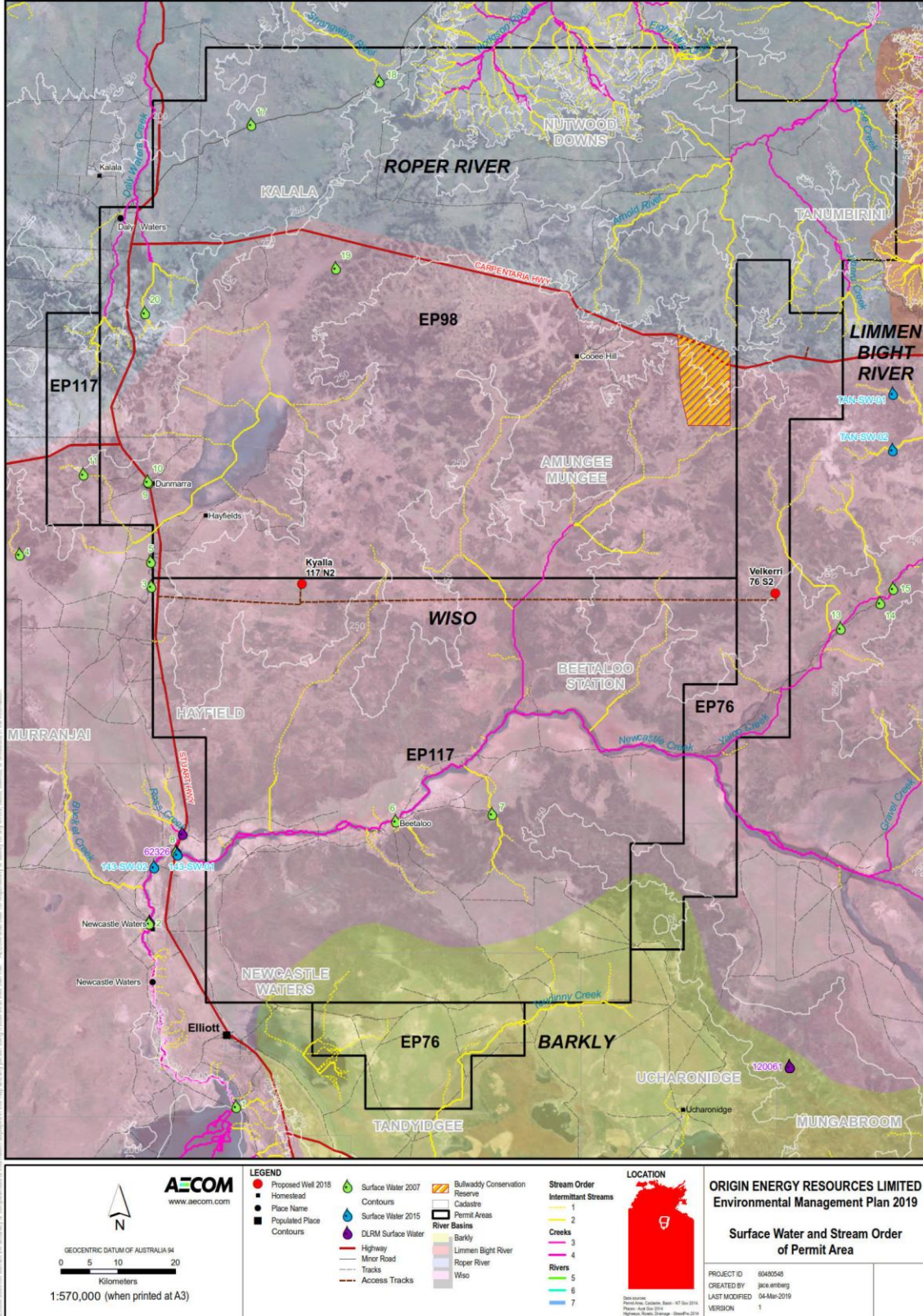
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# Primary Erosion and Sediment Control Plan

NT-2050-15-MP-019.

## Appendix D Permit Area Surface Water

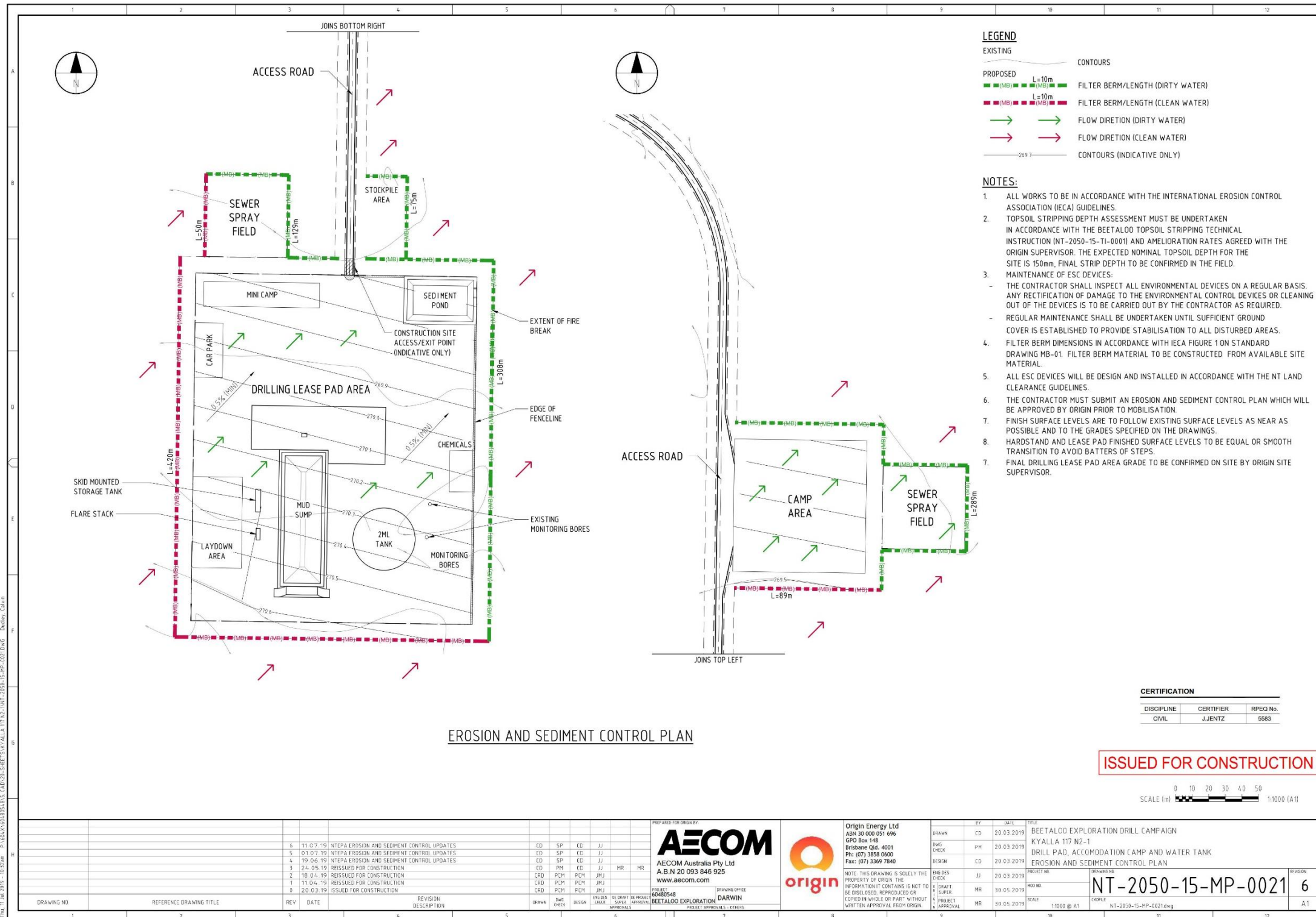


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A3 size

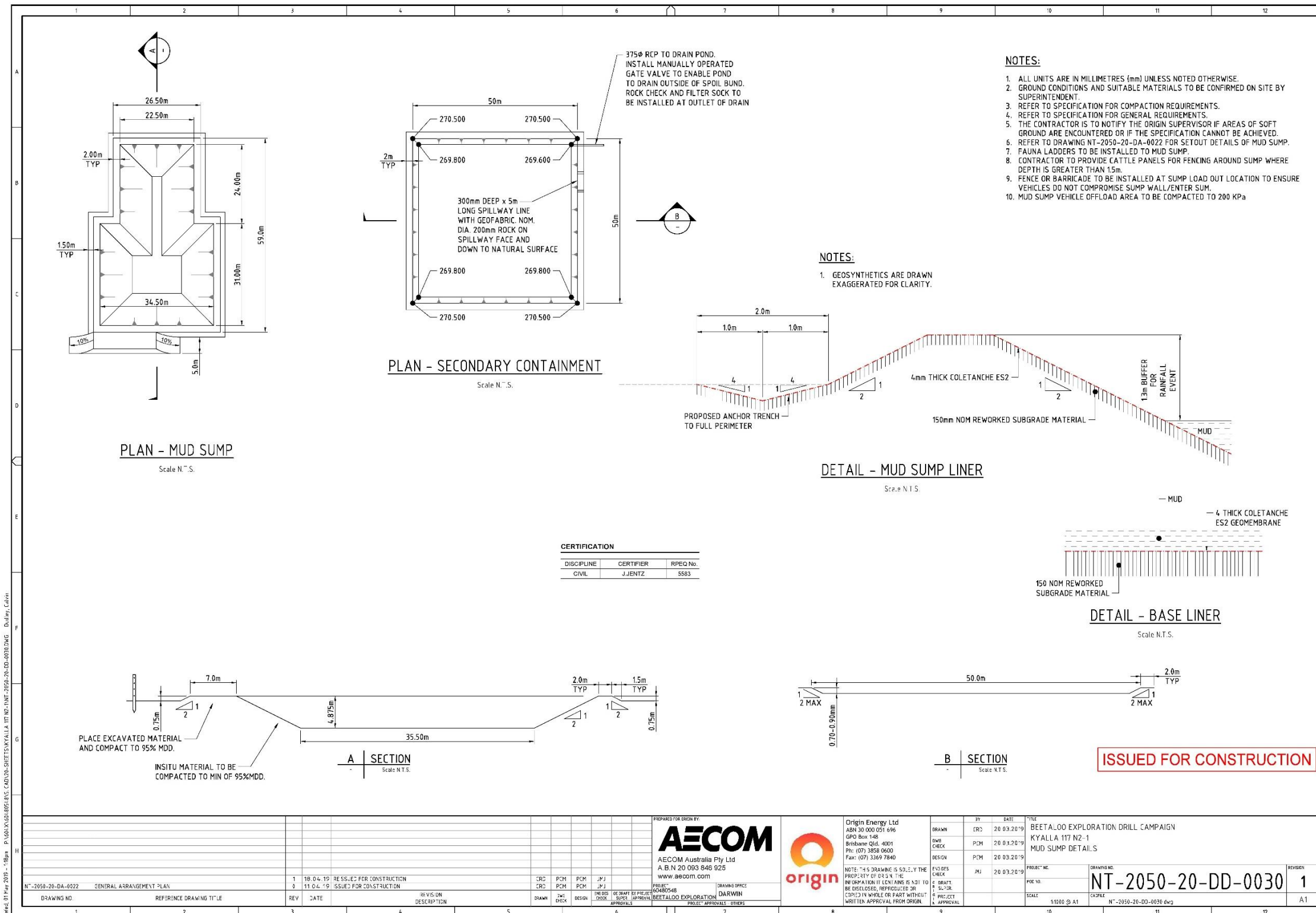
## Appendix E Erosion and Sediment Control Plan for Kyalla 117 N2-1



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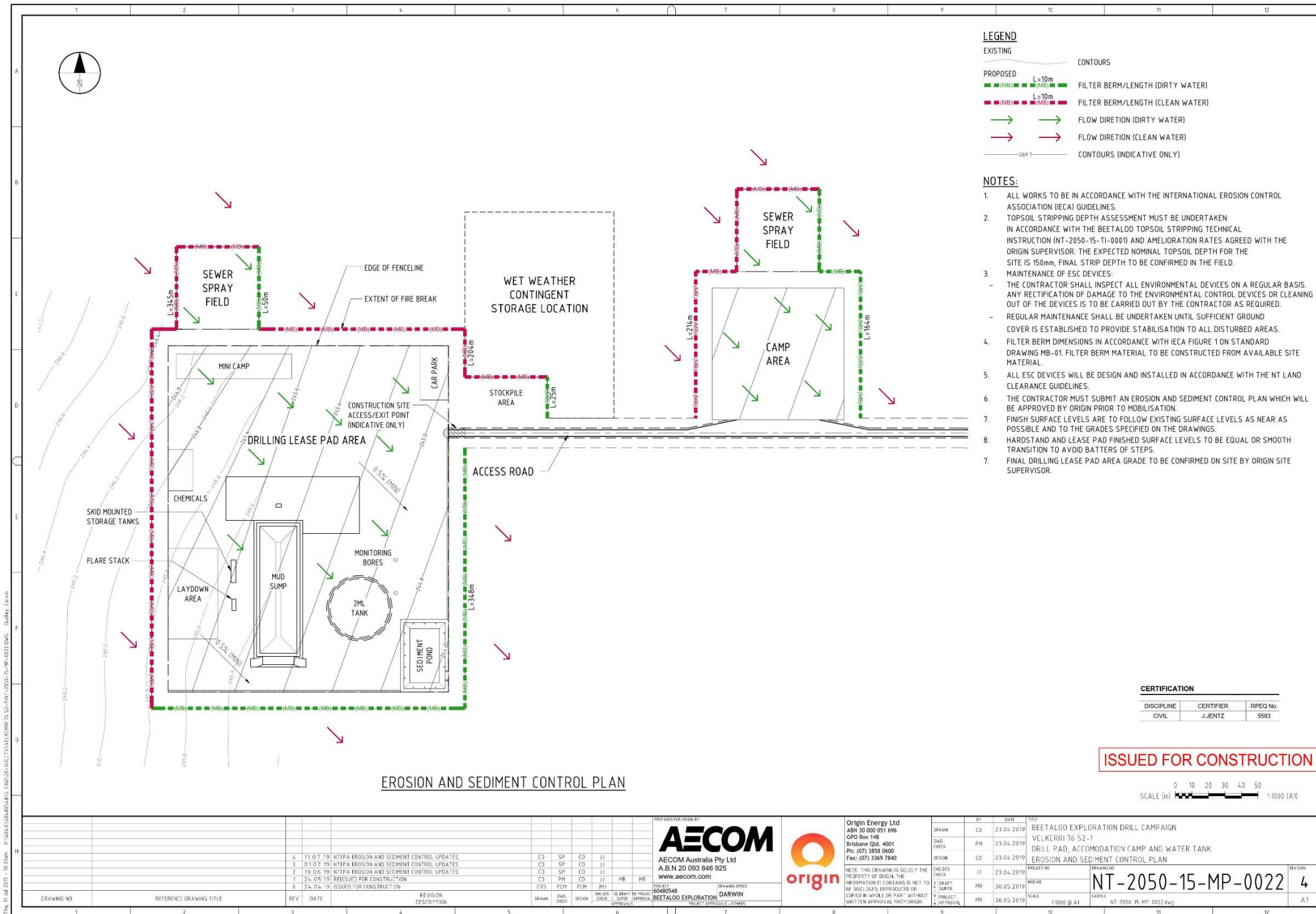


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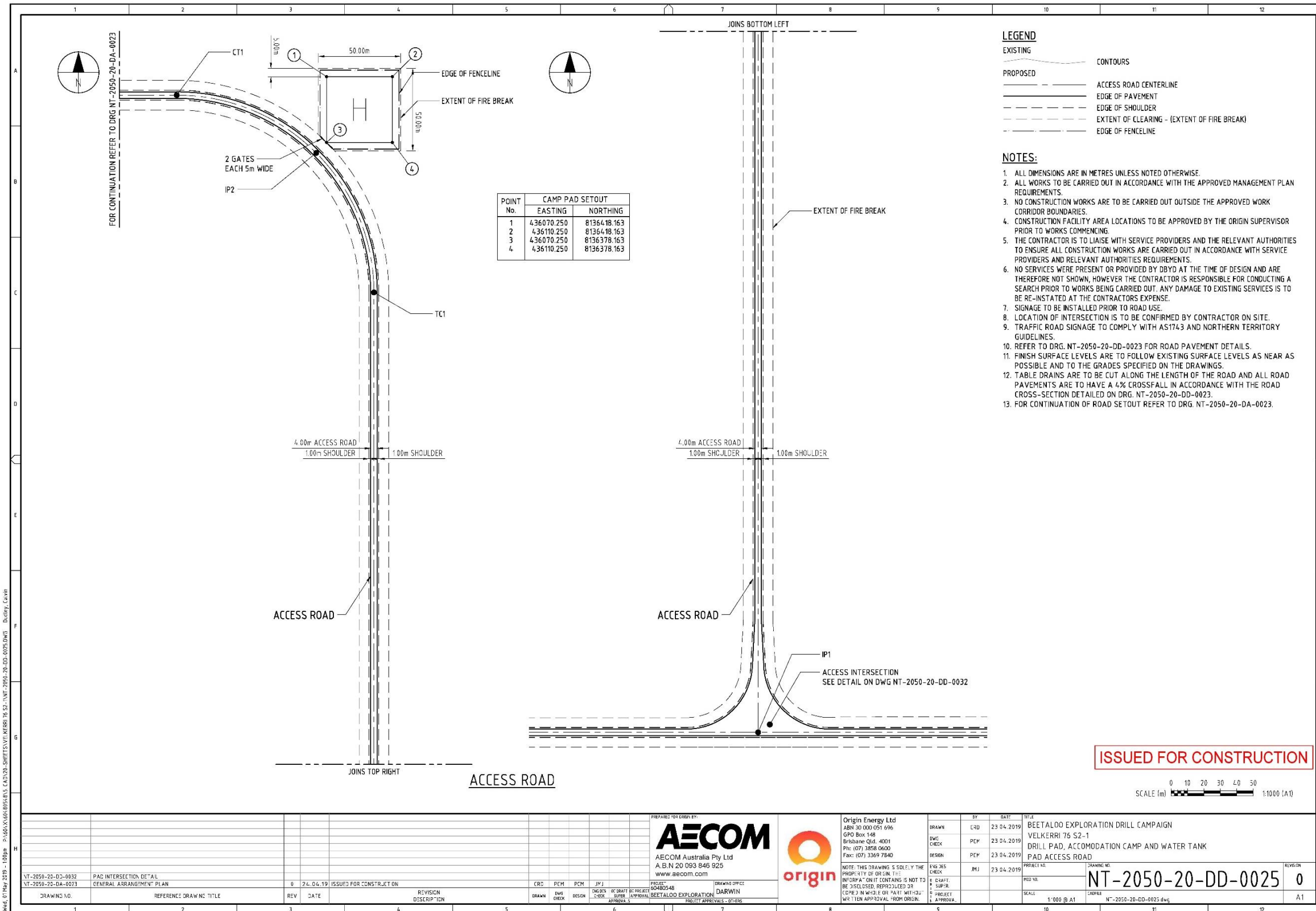
## Appendix F Erosion and Sediment Control Plan for Velkerri 76 S2-1



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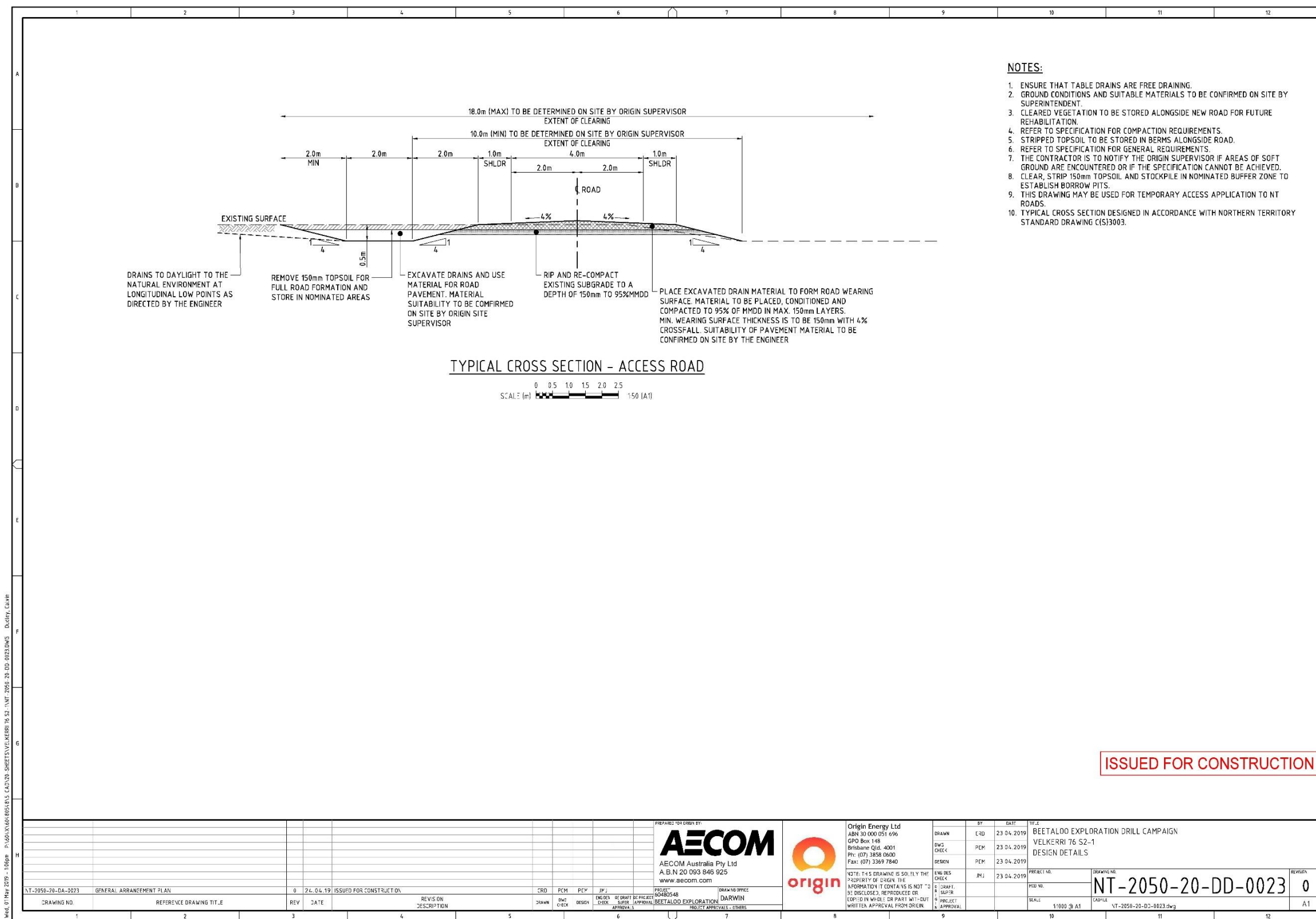


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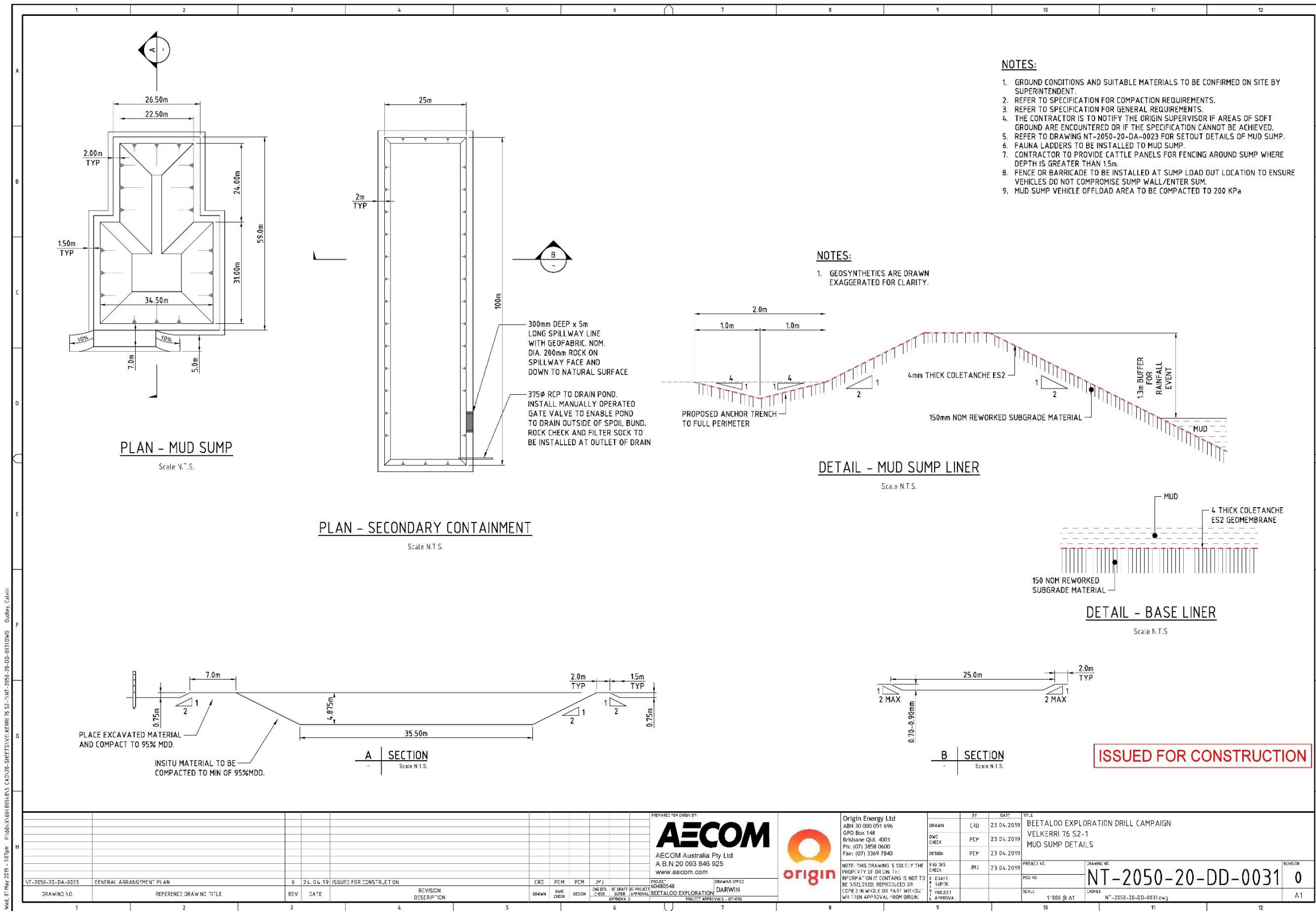
NT-2050-20-DA-0023  
 P:\660\NT\001\005\AS\CD\20\_SHEETS\VE\KERRI\_16\_S2\NT\_2050\_20\_DD\_0023.DWG - D:\CFY\Exam

DRAWING NO.		REFERENCE DRAWING TITLE		REV	DATE	DESCRIPTION	DRAWN	CHK	DESIGN	DATE	PROJECT	DRAWING OFFICE	DRAWN	CHK	DESIGN	DATE	TITLE	DRAWING NO.	REVISION
NT-2050-20-DA-0023		GENERAL ARRANGEMENT PLAN		0	24.04.19	ISSUED FOR CONSTRUCTION	CRD	PCM	PCM	23.04.2019	00480548	DARWIN	CRD	PCM	PCM	23.04.2019	BEE TALOO EXPLORATION DRILL CAMPAIGN VELKERRI 76 S2-1 DESIGN DETAILS	NT-2050-20-DD-0023	0
PREPARED FOR ORIGIN BY: <b>AECOM</b> Origin Energy Ltd ABN 30 000 051 696 GPO Box 148 Brisbane Qld. 4001 Ph: (07) 3858 0900 Fax: (07) 3369 7840 A.E.N. 20 093 845 925 www.aecom.com																			
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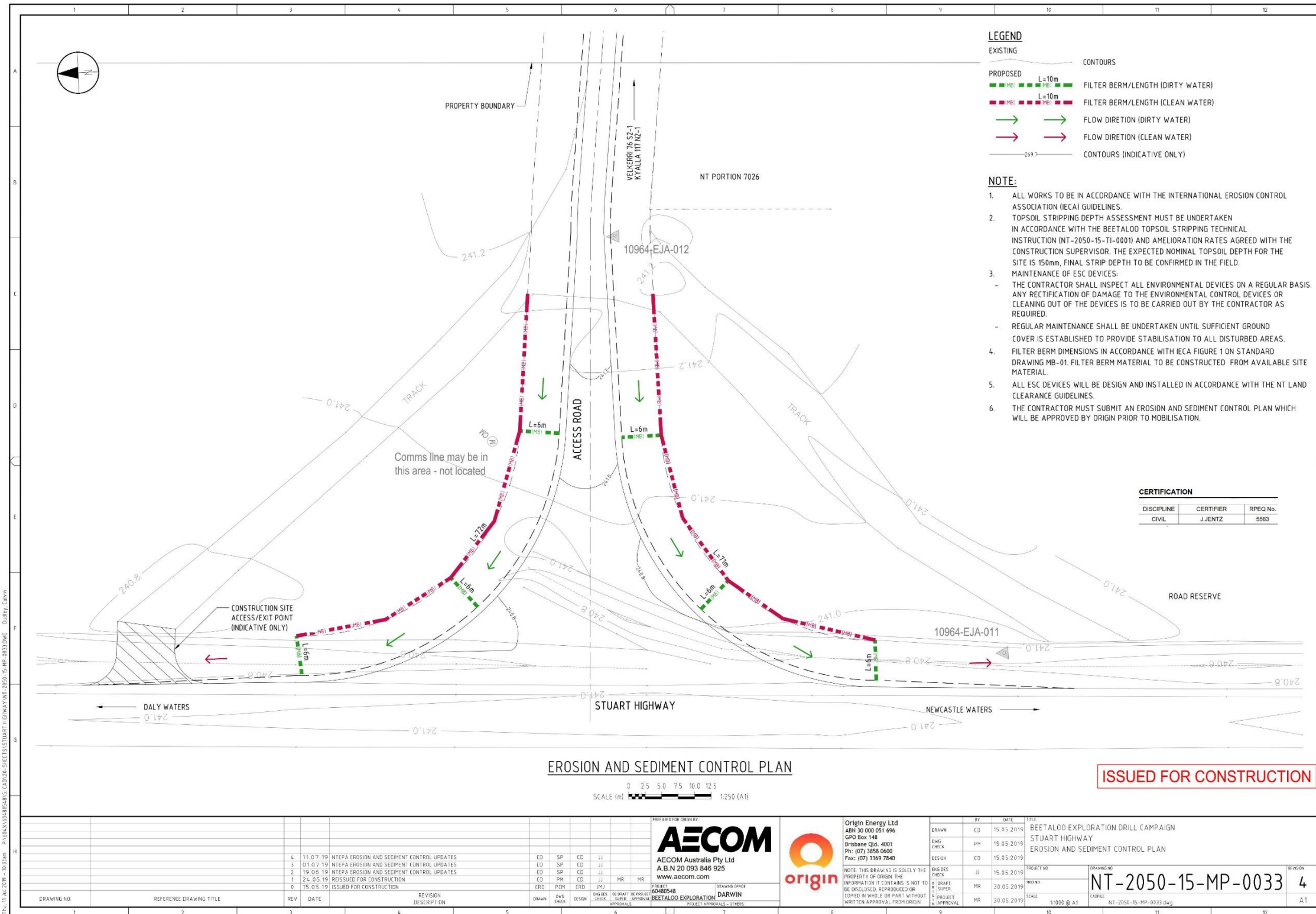


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## Appendix G Erosion and Sediment Control Plan for Stuart Highway Intersection Upgrade

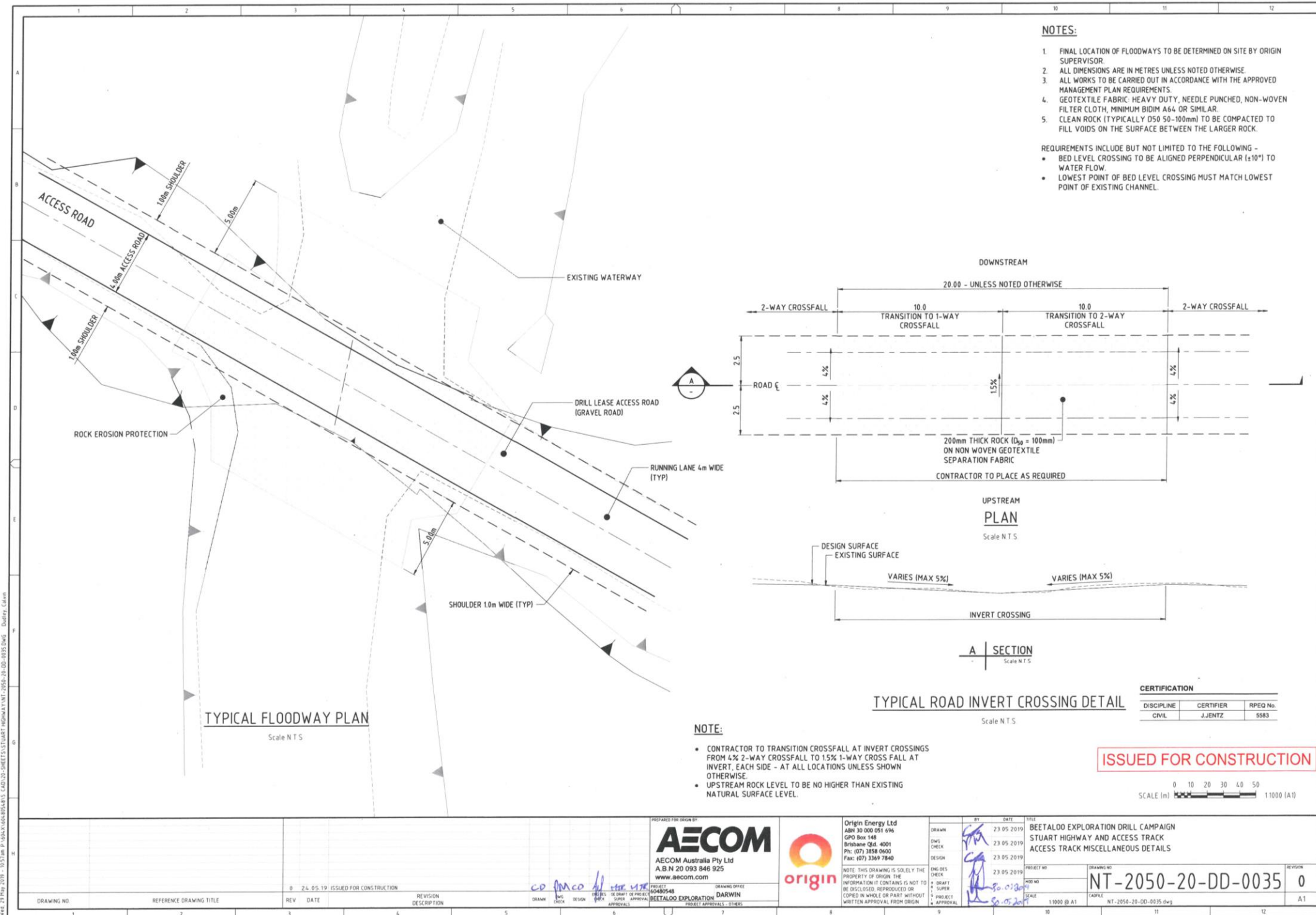


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## Appendix H Erosion and Sediment Control Plan for Typical Road Invert Crossing

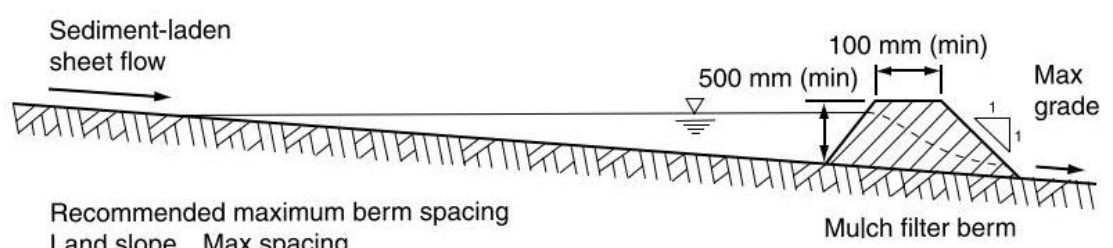


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## Appendix I Other IECA Standard Specifications (as required)

<p><b>MATERIALS</b></p> <p>(i) MULCH MUST COMPLY WITH THE REQUIREMENTS OF AS4454.</p> <p>(ii) MAXIMUM SOLUBLE SALT CONCENTRATION OF 5dS/m.</p> <p>(iii) MOISTURE CONTENT OF 30 TO 50% PRIOR TO APPLICATION.</p> <p><b>INSTALLATION</b></p> <p>1. REFER TO APPROVED PLANS FOR LOCATION AND EXTENT. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, MATERIAL TYPE, OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.</p> <p>2. WHEN SELECTING THE LOCATION OF A MULCH FILTER BERM, TO THE MAXIMUM DEGREE PRACTICAL, ENSURE THE BERM IS LOCATED:</p> <p>(i) TOTALLY WITHIN THE PROPERTY BOUNDARIES;</p> <p>(ii) ALONG A LINE OF CONSTANT ELEVATION (PREFERRED, BUT NOT ALWAYS PRACTICAL);</p> <p>(iii) AT LEAST 1m, IDEALLY 3m, FROM THE TOE OF A FILL EMBANKMENT;</p> <p>(iv) AWAY FROM AREAS OF CONCENTRATED FLOW.</p> <p>3. ENSURE THE BERM IS INSTALLED IN A MANNER THAT AVOIDS THE CONCENTRATION OF FLOW ALONG THE BERM, OR THE UNDESIRABLE DISCHARGE OF WATER AROUND THE END OF THE BERM.</p> <p>4. ENSURE THE BERM HAS BEEN PLACED SUCH THAT PONDING UP-SLOPE OF THE BERM IS MAXIMISED.</p>	<p>5. ENSURE BOTH ENDS OF THE BERM ARE ADEQUATELY TURNED UP THE SLOPE TO PREVENT FLOW BYPASSING PRIOR TO WATER PASSING OVER THE BERM.</p> <p>6. ENSURE 100% CONTACT WITH THE SOIL SURFACE.</p> <p>7. WHERE SPECIFIED, TAKE APPROPRIATE STEPS TO VEGETATE THE BERM.</p> <p><b>MAINTENANCE</b></p> <p>1. DURING THE CONSTRUCTION PERIOD, INSPECT ALL BERMS AT LEAST WEEKLY AND AFTER ANY SIGNIFICANT RAIN. MAKE NECESSARY REPAIRS IMMEDIATELY.</p> <p>2. REPAIR OR REPLACE ANY DAMAGED SECTIONS.</p> <p>3. WHEN MAKING REPAIRS, ALWAYS RESTORE THE SYSTEM TO ITS ORIGINAL CONFIGURATION UNLESS AN AMENDED LAYOUT IS REQUIRED OR SPECIFIED.</p> <p>4. REMOVE ACCUMULATED SEDIMENT IF THE SEDIMENT DEPOSIT EXCEEDS A DEPTH OF 100mm OR 1/3 THE HEIGHT OF THE BERM.</p> <p>5. DISPOSE OF SEDIMENT IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.</p>	<p><b>REMOVAL (IF REQUIRED)</b></p> <p>1. WHEN DISTURBED AREAS UP-SLOPE OF THE BERM ARE SUFFICIENTLY STABILISED TO RESTRAIN EROSION, THE BERM MAYBE REMOVED.</p> <p>2. REMOVE ANY COLLECTED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.</p> <p>3. REHABILITATE/REVEGETATE THE DISTURBED GROUND AS NECESSARY TO MINIMISE THE EROSION HAZARD.</p>	 <p style="text-align: center;">Recommended maximum berm spacing</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Land slope</th> <th>Max spacing</th> </tr> </thead> <tbody> <tr> <td>&lt; 2%</td> <td>30 m</td> </tr> <tr> <td>5%</td> <td>25 m</td> </tr> <tr> <td>10%</td> <td>15 m</td> </tr> <tr> <td>20%</td> <td>8 m</td> </tr> </tbody> </table>	Land slope	Max spacing	< 2%	30 m	5%	25 m	10%	15 m	20%	8 m
Land slope	Max spacing												
< 2%	30 m												
5%	25 m												
10%	15 m												
20%	8 m												

**Figure 1 - Typical placement of mulch filter berm**

Drawn:	Date:		
GMW	Apr-10	Mulch Filter Berms	MB-01

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**MATERIAL**

**ROCK MULCH:** 25–75mm DURABLE, WEATHER RESISTANT AND EVENLY GRADED WITH 50% BY WEIGHT LARGER THAN THE SPECIFIED NOMINAL ROCK SIZE (IF SPECIFIED).

**INSTALLATION**

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND APPLICATION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF APPLICATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. SPREAD ENOUGH ROCK TO COMPLETELY COVER THE SURFACE OF THE SOIL AT THE DENSITY OR THICKNESS SPECIFIED IN THE APPROVED PLANS. IF THE APPLICATION DENSITY IS NOT SUPPLIED, THEN APPLY AT A THICKNESS OF AT LEAST 50mm OR TWICE THE NOMINAL ROCK SIZE (WHICHEVER IS GREATER).

3. IF THE EXPOSED SOILS ARE DISPERSIVE, THEN ENSURE THESE SOILS ARE COVERED WITH A LAYER OF NON-DISPERSIVE SOIL (MINIMUM 200mm) BEFORE PLACEMENT OF ROCK.

4. MAKE ALL NECESSARY ADJUSTMENTS TO ENSURE ANY SURFACE FLOW IS ALLOWED TO PASS FREELY ACROSS THE TREATED AREA FOLLOWING ITS NATURAL DRAINAGE PATH.

**MAINTENANCE**

1. INSPECT ALL TREATED SURFACES FORTNIGHTLY AND AFTER RUNOFF-PRODUCING RAINFALL.

2. CHECK FOR RILL EROSION, OR DISLODGMET OF THE ROCKS.

3. REPLACE ANY DISPLACED ROCKS TO MAINTAIN THE REQUIRED COVERAGE.

4. IF WASH-OUTS OCCUR, REPAIR THE SLOPE AND REINSTALL ROCK COVER.

5. IF THE ROCK MULCHING IS NOT EFFECTIVE IN CONTAINING THE SOIL EROSION IT SHOULD BE REPLACED, OR AN ALTERNATIVE EROSION CONTROL PROCEDURE ADOPTED.

Catchments & Creeks Pty Ltd

Drawn:	Date:		
GMW	Dec-09	Rock Mulching	MR-01

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## PREPARATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND DIMENSIONAL DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, OR EXTENT, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.
2. TAKE ALL NECESSARY STEPS TO ENSURE DISTURBANCE TO THE BUFFER ZONE IS MINIMISED THROUGHOUT THE TIME IT IS USED AS A SEDIMENT TRAP.
3. TO THE MAXIMUM DEGREE PRACTICABLE, ENSURE FLOW PASSING THROUGH THE BUFFER ZONE IS NOT ALLOWED TO CONCENTRATE WITHIN DRAINAGE DEPRESSIONS, SWALES, RILLS OR WHEEL TRACKS.
4. WHERE NECESSARY, INSTALL APPROPRIATE DRAINAGE CONTROLS UP-SLOPE OF THE BUFFER ZONE TO DISTRIBUTE THE INFLOW ALONG THE FULLY LENGTH OF THE BUFFER ZONE AS 'SHEET FLOW'.
5. WHERE NECESSARY, INSTALL A COARSE SEDIMENT TRAP, SUCH AS A SEDIMENT FENCE, UP-SLOPE OF THE BUFFER ZONE TO REDUCE THE QUANTITY OF SEDIMENT PASSING ONTO THE GRASS. GENERALLY THIS IS REQUIRED IF LARGE QUANTITIES OF COARSE SEDIMENT ARE EXPECTED.

6. IF REQUIRED, INSTALL A LIGHT BARRIER FENCE TO CLEARLY IDENTIFY THE BUFFER ZONE AND HELP EXCLUDE CONSTRUCTION TRAFFIC.

## MAINTENANCE

1. INSPECT THE BUFFER ZONE ON A REGULAR BASIS AND AFTER RUNOFF-PRODUCING RAINFALL.
2. ENSURE THAT THERE IS NO SOIL EROSION AND THAT SEDIMENT DEPOSITION IS NOT CAUSING THE CONCENTRATION OF FLOW THROUGH THE BUFFER ZONE, OR FLOW BYPASSING.
3. IF THE BUFFER ZONE HAS BEEN DISTURBED, TAKE NECESSARY STEPS TO RE-ESTABLISH SUITABLE SHEET FLOW CONDITIONS.
4. REMOVE EXCESSIVE ACCUMULATIONS OF SEDIMENT THAT MAY CAUSE THE CONCENTRATION OF FLOW. EXCESSIVE SEDIMENT SHOULD BE REMOVED AFTER EACH RUNOFF-PRODUCING RAINFALL EVENT, OR WHERE APPROPRIATE, EVENLY RAKED INTO THE SOIL. SEDIMENT SHOULD BE REMOVED IN A MANNER THAT AVOIDS DAMAGE TO THE BUFFER ZONE OR THE CREATION OF WHEEL TRACKS DOWN THE SLOPE.

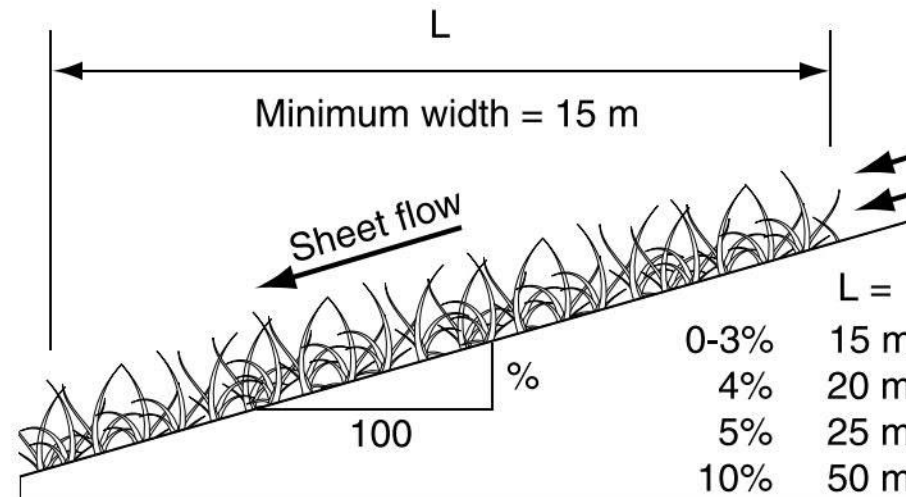
5. EXCESSIVE SEDIMENT MAY BE DEFINED AS:

- (i) ANY SEDIMENT THAT COVERS A PORTION OF THE GRASSED SURFACE; OR
- (ii) SEDIMENT DEPOSITION SUCH THAT THE GRASS STRAND HEIGHT ABOVE THE SEDIMENT IS LESS THAN 50mm; OR
- (iii) A DEPOSITION OF SEDIMENT IN EXCESS OF 750g/m<sup>2</sup> (APPROXIMATELY THE EQUIVALENT OF THREE 70mm DIAMETER BALLS OF DRY SOIL).

6. THE SOURCE OF ANY EXCESSIVE SEDIMENT SHOULD BE INVESTIGATED AND CONTROLLED WHERE PRACTICAL.

7. TAKE APPROPRIATE STEPS TO MAINTAIN AT LEAST 75% GRASS COVER OVER THE BUFFER ZONE.

8. WHERE PRACTICAL, MAINTAIN ANY GROUND COVER VEGETATION AT A HEIGHT GREATER THAN THE EXPECTED DEPTH OF WATER FLOW AND AT LEAST 50mm.



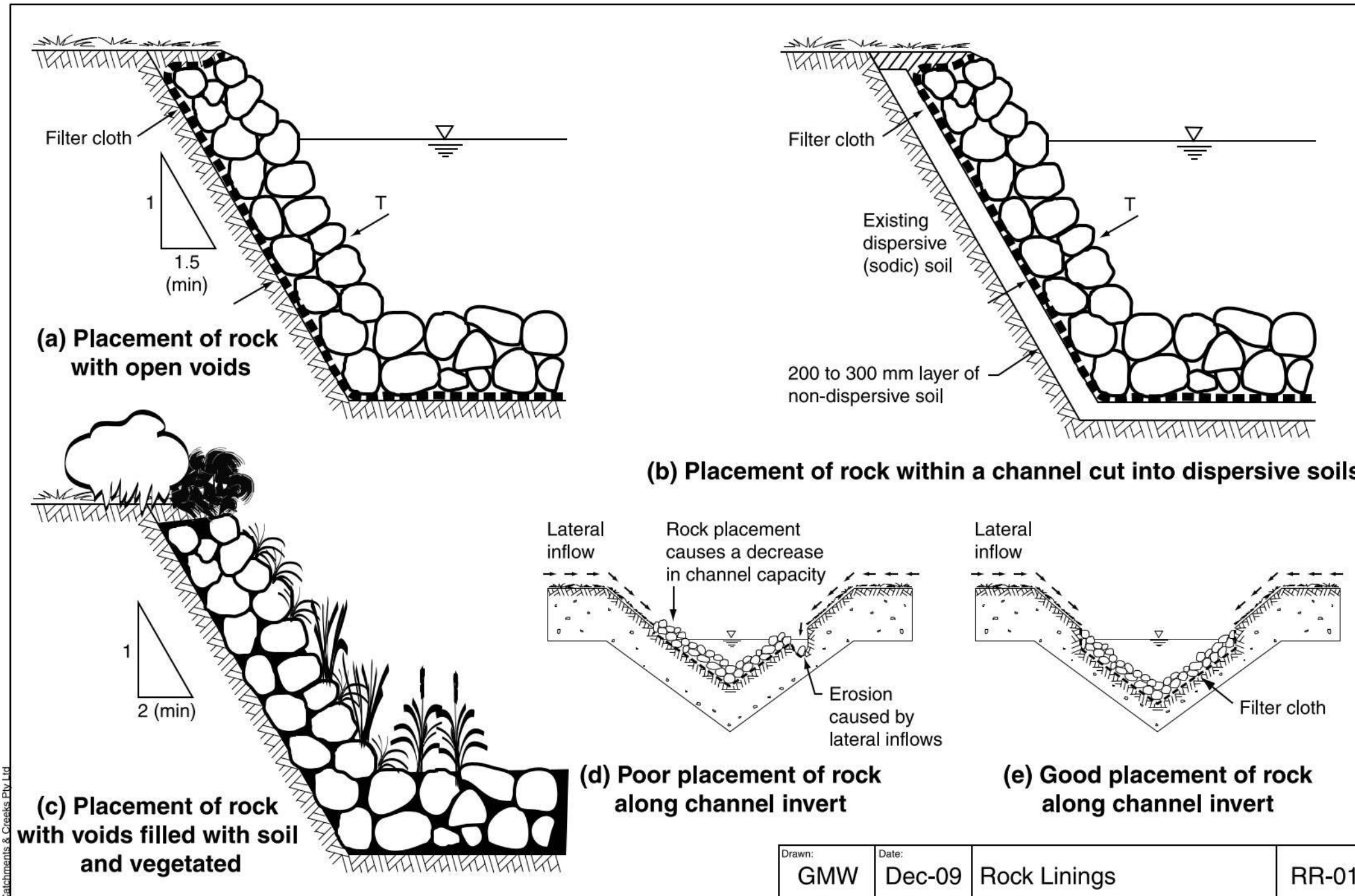
**Figure 1 - Minimum dimensional requirements of a grassed buffer zone**

Drawn:	Date:		
GMW	Apr-10	Buffer Zones (grassed)	BZ-01

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**MATERIALS**

**ROCK:** HARD, ANGULAR, DURABLE, WEATHER RESISTANT AND EVENLY GRADED WITH 50% BY WEIGHT LARGER THAN THE SPECIFIED NOMINAL ROCK SIZE AND SUFFICIENT SMALL ROCK TO FILL THE VOIDS BETWEEN THE LARGER ROCK. THE DIAMETER OF THE LARGEST ROCK SIZE SHOULD BE NO LARGER THAN 1.5 TIMES THE NOMINAL ROCK SIZE. SPECIFIC GRAVITY TO BE AT LEAST 2.5.

**GEOTEXTILE FABRIC:** HEAVY-DUTY, NEEDLE-PUNCHED, NON-WOVEN FILTER CLOTH, MINIMUM BIDIM A24 OR EQUIVALENT.

**INSTALLATION**

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT AND INSTALLATION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. CLEAR THE PROPOSED CHANNEL AREA OF TREES, STUMPS, ROOTS, LOOSE ROCK, AND OTHER OBJECTIONABLE MATERIALS.

3. EXCAVATE THE CHANNEL TO THE LINES AND GRADES AS SHOWN ON THE PLANS. OVER-CUT THE CHANNEL TO A DEPTH EQUAL TO THE SPECIFIED DEPTH OF ROCK PLACEMENT SUCH THAT THE FINISHED ROCK SURFACE WILL BE AT THE ELEVATION OF THE SURROUNDING LAND.

4. ROCK MUST BE PLACED WITHIN THE CHANNEL AS SPECIFIED WITHIN THE APPROVED PLANS, INCLUDING THE PLACEMENT OF ANY SPECIFIED FILTER LAYER.

5. IF DETAILS ARE NOT PROVIDED ON THE ROCK PLACEMENT, THEN THE PRIMARY ARMOUR ROCK MUST BE EITHER PLACED ON:

- (i) A FILTER BED FORMED FROM A LAYER OF SPECIFIED SMALLER ROCK (ROCK FILTER LAYER);
- (ii) AN EARTH BED LINED WITH FILTER CLOTH;
- (iii) AN EARTH BED NOT LINED IN FILTER CLOTH, BUT ONLY IF ALL VOIDS BETWEEN THE ARMOUR ROCK ARE TO BE FILLED WITH SOIL AND POCKET PLANTED IMMEDIATELY AFTER PLACEMENT OF THE ROCK.

6. IF A ROCK/AGGREGATE FILTER LAYER IS SPECIFIED, THEN PLACE THE FILTER LAYER IMMEDIATELY AFTER THE FOUNDATIONS ARE PREPARED. SPREAD THE FILTER ROCK IN A UNIFORM LAYER TO THE SPECIFIED DEPTH BUT A MINIMUM OF 150mm. WHERE MORE THAN ONE LAYER OF FILTER MATERIAL HAS BEEN SPECIFIED, SPREAD EACH LAYER SUCH THAT MINIMAL MIXING OCCURS BETWEEN EACH LAYER OF ROCK.

7. IF A GEOTEXTILE (FILTER CLOTH) UNDERLAY IS SPECIFIED, PLACE THE FABRIC DIRECTLY ON THE PREPARED FOUNDATION. IF MORE THAN ONE SHEET OF FABRIC IS REQUIRED TO COVER THE AREA, OVERLAP THE EDGE OF EACH SHEET AT LEAST 300mm AND PLACE ANCHOR PINS AT MINIMUM 1m SPACING ALONG THE OVERLAP.

8. ENSURE THE GEOTEXTILE FABRIC IS PROTECTED FROM PUNCHING OR TEARING DURING INSTALLATION OF THE FABRIC AND THE ROCK. REPAIR ANY DAMAGE BY REMOVING THE ROCK AND PLACING WITH ANOTHER PIECE OF FILTER CLOTH OVER THE DAMAGED AREA

OVERLAPPING THE EXISTING FABRIC A MINIMUM OF 300mm.

9. WHERE NECESSARY, A MINIMUM 100mm LAYER OF FINE GRAVEL, AGGREGATE OR SAND SHOULD BE PLACED OVER THE FABRIC TO PROTECT IT FROM DAMAGE.

10. PLACEMENT OF ROCK SHOULD FOLLOW IMMEDIATELY AFTER PLACEMENT OF THE FILTER LAYER. PLACE ROCK SO THAT IT FORMS A DENSE, WELL-GRADED MASS OF ROCK WITH A MINIMUM OF VOIDS.

11. PLACE ROCK TO ITS FULL THICKNESS IN ONE OPERATION. DO NOT PLACE ROCK BY DUMPING THROUGH CHUTES OR OTHER METHODS THAT CAUSE SEGREGATION OF ROCK SIZES.

12. THE FINISHED SURFACE SHOULD BE FREE OF POCKETS OF SMALL ROCK OR CLUSTERS OF LARGE ROCKS. HAND PLACING MAY BE NECESSARY TO ACHIEVE THE PROPER DISTRIBUTION OF ROCK SIZES TO PRODUCE A RELATIVELY SMOOTH, UNIFORM SURFACE. THE FINISHED GRADE OF THE ROCK SHOULD BLEND WITH THE SURROUNDING AREA. NO OVERFALL OR PROTRUSION OF ROCK SHOULD BE APPARENT.

13. IMMEDIATELY UPON COMPLETION OF THE CHANNEL, VEGETATE ALL DISTURBED AREAS OR OTHERWISE PROTECT THEM AGAINST SOIL EROSION.

14. WHERE SPECIFIED, FILL ALL VOIDS WITH SOIL AND VEGETATE THE ROCK SURFACE IN ACCORDANCE WITH THE APPROVED PLAN.

**MAINTENANCE**

1. ROCK-LINED CHANNELS SHOULD BE INSPECTED PERIODICALLY AND AFTER SIGNIFICANT STORM EVENTS. CHECK FOR SCOUR OR DISLODGED ROCK. REPAIR DAMAGED AREAS IMMEDIATELY.

2. CLOSELY INSPECT THE OUTER EDGES OF THE ROCK PROTECTION. ENSURE WATER ENTRY INTO THE CHANNEL OR CHUTE IS NOT CAUSING EROSION ALONG THE EDGE OF THE ROCK PROTECTION.

3. CAREFULLY CHECK THE STABILITY OF THE ROCK LOOKING FOR INDICATIONS OF PIPING, SCOUR HOLES, OR BANK FAILURES.

4. REPLACE ANY DISPLACED ROCK WITH ROCK OF A SIGNIFICANTLY (MINIMUM 110%) LARGER SIZE THAN THE DISPLACED ROCK.

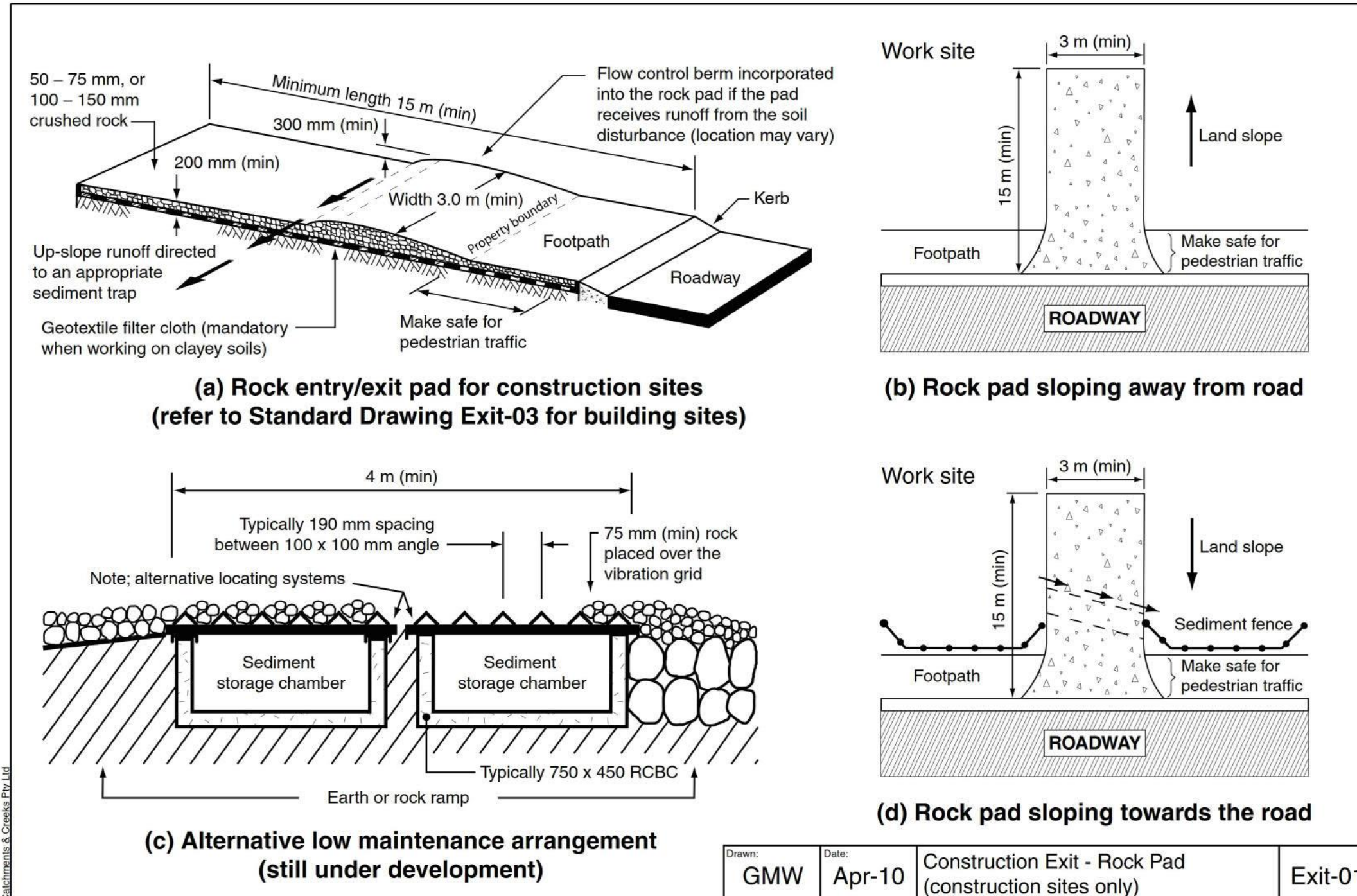
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Drawn:	Date:		
GMW	May-10	Rock Linings	RR-02

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<p><b>MATERIALS</b></p> <p><b>ROCK:</b> WELL GRADED, HARD, ANGULAR, EROSION RESISTANT ROCK, NOMINAL DIAMETER OF 50 TO 75mm (SMALL DISTURBANCES) OR 100 TO 150mm (LARGE DISTURBANCES). ALL REASONABLE MEASURES MUST BE TAKEN TO OBTAIN ROCK OF NEAR UNIFORM SIZE.</p> <p><b>FOOTPATH STABILISING AGGREGATE:</b> 25 TO 50mm GRAVEL OR AGGREGATE.</p> <p><b>GEOTEXTILE FABRIC:</b> HEAVY-DUTY, NEEDLE-PUNCHED, NON-WOVEN FILTER CLOTH ('BIDIM' A24 OR EQUIVALENT).</p> <p><b>INSTALLATION</b></p> <p>1. REFER TO APPROVED PLANS FOR LOCATION AND DIMENSIONAL DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, DIMENSIONS, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.</p> <p>2. CLEAR THE LOCATION OF THE ROCK PAD, REMOVING STUMPS, ROOTS AND OTHER VEGETATION TO PROVIDE A FIRM FOUNDATION SO THAT THE ROCK IS NOT PRESSED INTO SOFT GROUND. CLEAR SUFFICIENT WIDTH TO ALLOW PASSAGE OF LARGE VEHICLES, BUT CLEAR ONLY THAT NECESSARY FOR THE EXIT. DO NOT CLEAR ADJACENT AREAS UNTIL THE REQUIRED EROSION AND SEDIMENT CONTROL DEVICES ARE IN PLACE.</p> <p>3. IF THE EXPOSED SOIL IS SOFT, PLASTIC OR CLAYEY, PLACE A SUB-BASE OF CRUSHED ROCK OR A LAYER OF HEAVY-DUTY FILTER CLOTH TO PROVIDE A FIRM FOUNDATION.</p>	<p>4. PLACE THE ROCK PAD FORMING A MINIMUM 200mm THICK LAYER OF CLEAN, OPEN-VOID ROCK.</p> <p>5. IF THE ASSOCIATED CONSTRUCTION SITE IS UP-SLOPE OF THE ROCK PAD, THUS CAUSING STORMWATER RUNOFF TO FLOW TOWARDS THE ROCK PAD, THEN FORM A MINIMUM 300mm HIGH FLOW CONTROL BERM ACROSS THE ROCK PAD TO DIVERT SUCH RUNOFF TO A SUITABLE SEDIMENT TRAP.</p> <p>6. THE LENGTH OF THE ROCK PAD SHOULD BE AT LEAST 15m WHERE PRACTICABLE, AND AS WIDE AS THE FULL WIDTH OF THE ENTRY OR EXIT AND AT LEAST 3m. THE ROCK PAD SHOULD COMMENCE AT THE EDGE OF THE OFF-SITE SEALED ROAD OR PAVEMENT.</p> <p>7. FLARE THE END OF THE ROCK PAD WHERE IT MEETS THE PAVEMENT SO THAT THE WHEELS OF TURNING VEHICLES DO NOT TRAVEL OVER UNPROTECTED SOIL.</p> <p>8. IF THE FOOTPATH IS OPEN TO PEDESTRIAN MOVEMENT, THEN COVER THE COARSE ROCK WITH FINE AGGREGATE OR GRAVEL, OR OTHERWISE TAKE WHATEVER MEASURES ARE NEEDED TO MAKE THE AREA SAFE.</p>	<p><b>MAINTENANCE</b></p> <p>1. INSPECT ALL SITE ENTRY AND EXIT POINTS PRIOR TO FORECAST RAIN, DAILY DURING EXTENDED PERIODS OF RAINFALL, AFTER RUNOFF-PRODUCING RAINFALL, OR OTHERWISE AT FORTNIGHTLY INTERVALS.</p> <p>2. IF SAND, SOIL, SEDIMENT OR MUD IS TRACKED OR WASHED ONTO THE ADJACENT SEALED ROADWAY, THEN SUCH MATERIAL MUST BE PHYSICALLY REMOVED, FIRST USING A SQUARE-EDGED SHOVEL, AND THEN A STIFF-BRISTLED BROOM, AND THEN BY A MECHANICAL VACUUM UNIT, IF AVAILABLE.</p> <p>3. IF NECESSARY FOR SAFETY REASONS, THE ROADWAY SHALL ONLY BE WASHED CLEAN AFTER ALL REASONABLE EFFORTS HAVE BEEN TAKEN TO SHOVEL AND SWEEP THE MATERIAL FROM THE ROADWAY.</p> <p>4. WHEN THE VOIDS BETWEEN THE ROCK BECOMES FILLED WITH MATERIAL AND THE EFFECTIVENESS OF THE ROCK PAD IS REDUCED TO A POINT WHERE SEDIMENT IS BEING TRACKED OFF THE SITE, A NEW 100mm LAYER OF ROCK MUST BE ADDED AND/OR THE ROCK PAD MUST BE EXTENDED.</p> <p>5. ENSURE ANY ASSOCIATED DRAINAGE CONTROL MEASURES (e.g. FLOW CONTROL BERM) ARE MAINTAINED IN ACCORDANCE WITH THEIR DESIRED OPERATIONAL CONDITIONS.</p>	<p>6. DISPOSE OF SEDIMENT AND DEBRIS IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.</p> <p><b>REMOVAL</b></p> <p>1. THE ROCK PAD SHOULD BE REMOVED ONLY AFTER IT IS NO LONGER NEEDED AS A SEDIMENT TRAP.</p> <p>2. REMOVE MATERIALS AND COLLECTED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.</p> <p>3. RE-GRADE AND STABILISE THE DISTURBED GROUND AS NECESSARY TO MINIMISE THE EROSION HAZARD.</p>				
<table border="1"> <tr> <td>Drawn: <b>GMW</b></td> <td>Date: <b>Apr-10</b></td> <td>Construction Exit - Rock Pad (construction sites only)</td> <td>Exit-02</td> </tr> </table>				Drawn: <b>GMW</b>	Date: <b>Apr-10</b>	Construction Exit - Rock Pad (construction sites only)	Exit-02
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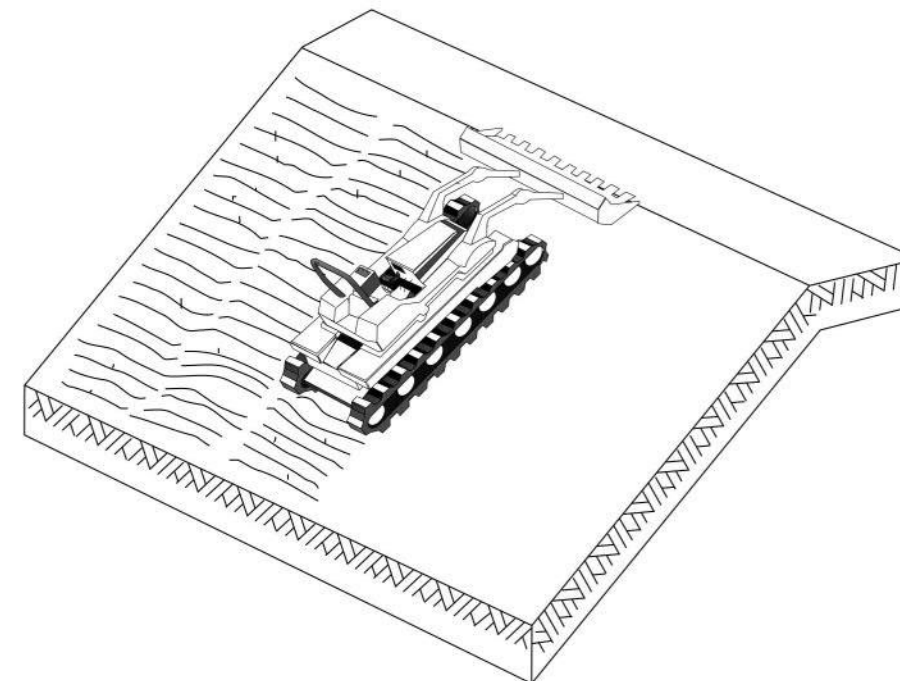
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### APPLICATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND APPLICATION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF APPLICATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.
2. FILL OR SUITABLY CONTOUR ANY EXISTING RUTTING, RILLING OR GULLIES.
3. SUITABLY DIVERT UP-SLOPE STORMWATER RUNOFF AROUND TREATED AREA AS DIRECTED WITHIN THE APPROVED PLANS, OR OTHERWISE AS DIRECTED BY THE SITE ENGINEER.
4. APPLY TREATMENT TO THE AREA TO THE DEPTH AND FREQUENCY (SPACING) SPECIFIED ON THE APPROVED PLANS, OR OTHERWISE AS DIRECTED BY THE SITE ENGINEER.
5. IMMEDIATELY SEED AND MULCH ROUGHENED AREAS TO OPTIMISE SEED GERMINATION AND GROWING CONDITIONS.

### MAINTENANCE

1. DURING THE CONSTRUCTION PERIOD, INSPECT THE TREATED AREA PRIOR TO FORECAST RAINFALL, DAILY DURING EXTENDED PERIODS OF RAINFALL, AFTER SIGNIFICANT RUNOFF PRODUCING RAINFALL, OR OTHERWISE ON A WEEKLY BASIS.
2. FILL EROSION RILLS SLIGHTLY ABOVE THE ORIGINAL GRADE, OR REGRADE THE SLOPE AS DIRECTED TO REMOVE THE RILLS.



**Figure 1 - Application of surface roughening on slope**

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GMW	Dec-09	Surface Roughening	SR-01

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# Primary Erosion and Sediment Control Plan

NT-2050-15-MP-019.

## Appendix J Erosion and Sediment Control Checklist

Site establishment		N/A – Not Applicable A – Acceptable Controls Adopted N – measure are not acceptable, or potential problem exists.
Item	Consideration	Assessment
1	Site access points limited to the minimum necessary, clearly identified on plans, and appropriate controls specified.	.....
2	Drainage controls indicated on the entry/exit pad (if necessary).	.....
3	Site office and car parking areas identified and provided with adequate drainage, erosion and sediment controls.	.....
4	Technical notes included on best practice site management including dust, chemical, oil, fuel, litter and debris control.	.....
5	Stockpile locations clearly identified and located away from protected vegetation and overland flow paths.	.....
6	Stockpiles located at least 5m away from top of watercourse banks.	.....
7	Adequate up-slope drainage controls (if necessary) and down-slope sediment controls placed adjacent to stockpiles.	.....
8	Temporary access roads/tracks identified, with appropriate drainage/erosion controls specified.	.....
9	<i>Temporary Watercourse Crossings</i> identified and protected.	.....
10	<i>Temporary Watercourse Crossings</i> are appropriate for fish passage requirements.	N/A .....
11	Minimum non-disturbance zone between unsealed access tracks and the edge of streams is at least the width of the stream (measured at the top of the bank) or 30m whichever is the lesser.	.....

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# Primary Erosion and Sediment Control Plan

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Drainage Controls		N/A – Not Applicable A – Acceptable Controls Adopted N – measure are not acceptable, or potential problem exists.
Item	Consideration	Assessment
1	All temporary construction roads and access tracks shown on the ESC Plan.	.....
2	Flow from “clean” external catchments diverted around/through site in a non-erosive manner.	.....
3	Internal “dirty” water drainage lines identified and directed to sediment controls.	.....
4	Appropriate drainage controls located immediately up-slope of neighbouring, down-slope residential areas.	.....
5	All site drainage inflow and outflow points identified.	.....
6	All water discharges from the site at legal points of discharge.	.....
7	All water discharges through stabilised outlets onto stable land.	.....
8	Maximum spacing of drains on long, open soil slopes is appropriate for the gradient and soil type.	.....
9	Appropriate flow velocity controls (e.g. <i>Check Dams</i> ) or scour controls (e.g. turf or <i>Erosion Control Mats</i> ) specified.	.....
10	<i>Catch Drains</i> or <i>Flow Diversion Banks</i> located at top of cut and fill batters.	.....
11	Temporary <i>Catch Drains</i> <u>not</u> indicated on dispersive soils.	.....
12	Rock <i>Check Dams</i> <u>not</u> specified in shallow (i.e. < 500mm deep) drains.	.....
13	Water flow is appropriately conveyed down constructed earth slopes (e.g. through <i>Slope Drains</i> or <i>Chutes</i> ).	.....
14	All <i>Slope Drains</i> and <i>Chutes</i> have stabilised inlets and outlets.	.....
15	Appropriate drainage controls on unsealed roads and access tracks.	.....
16	Overland flow appropriately controlled around <i>Temporary Watercourse Crossings</i> .	

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# Primary Erosion and Sediment Control Plan

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Erosion control		N/A – Not Applicable A – Acceptable Controls Adopted N – measure are not acceptable, or potential problem exists.
Item	Consideration	Assessment
1	The erosion control standard is consistent with the requirements of regulatory authority.	.....
2	Specified mulch stabilisation measures are appropriate for the soil slope (gradient).	.....
3	Appropriate drainage controls installed to minimise mulch being washed off the slope/site.	.....
4	Synthetic (plastic) mesh reinforced <i>Erosion Control Blankets</i> <u>not</u> specified in or adjacent to susceptible wildlife habitats.	.....
5	Emergency short-term erosion control measures specified (e.g. in event of construction delays, pre-storm activities).	.....
6	Technical notes indicate what additional works are required if construction occurs during the wet season.	.....
7	Dust control measures specified.	.....

Site Stabilisation/Revegetation		N/A – Not Applicable A – Acceptable Controls Adopted N – measure are not acceptable, or potential problem exists.
Item	Consideration	Assessment
1	Vegetation Management Plan and/or Landscape Plan provided.	.....
2	Site stabilisation/rehabilitation plan provided.	.....
3	Minimum soil protective cover of 70 % specified on ESCP or in the Supporting Documentation.	.....
4	Appropriate soil preparation measures specified prior to revegetation.	.....
5	Timing and specification for any temporary vegetation is provided.	.....
6	Application of permanent site revegetation is appropriately staged.	.....
7	Minimum specifications for imported topsoil supplied.	.....
8	Specifications and application rates for soil adjustments provided (soil report).	.....
9	Specifications and application rates for seeding, mulches and hydraulically applied soil covers provided.	.....

Supplementary Sediment Controls		N/A – Not Applicable A – Acceptable Controls Adopted N – measure are not acceptable, or potential problem exists.
Item	Consideration	Assessment
1	Every appropriate opportunity has been taken to trap sediment as close to the initial source of erosion as is practicable <u>without</u> placing sediment controls in locations where they could cause hydraulic, erosion, or safety issues.	.....
2	Sediment traps placed on public roadways will <u>not</u> cause safety issues.	.....
3	No sub-catchment relies solely on supplementary sediment control measures.	.....

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# Primary Erosion and Sediment Control Plan

NT-2050-15-MP-019.

4	<i>Straw Bales</i> are <u>not</u> specified for sediment control, unless justified by <u>exceptional</u> circumstances (e.g. as a short-term control during the installation of the primary sediment trap).	.....
5	The ESCP provides sufficient information to control the installation and use of supplementary sediment traps.	.....

Sediment Control Sheet Flow		N/A – Not Applicable A – Acceptable Controls Adopted N – measure are not acceptable, or potential problem exists.
Item	Consideration	Assessment
1	No sediment-laden water leaves the site untreated.	.....
2	“Sheet flow” control measures (e.g. <i>Buffer Zones</i> , <i>Grassed Filter Strips</i> , and <i>Sediment Fence</i> ) <u>not</u> specified in areas of concentrated flow.	.....
3	<i>Grass Filter Strips</i> will not cause water to be diverted along the up-slope edge of the filter strip.	.....
4	The width of sediment control <i>Buffer Zones</i> is appropriate for the land slope (gradient).	.....
5	Geotextile <i>Filter Fences</i> are only used to control sediment runoff from earth stockpiles.	.....
6	<i>Sediment Fences</i> : (a) Located (i.e. with regular “returns”) such that runoff will pond uniformly or a regular intervals along the fence. (b) Ends of each fence turned up the slope to control flow bypass. (c) Each fence clearly identified as either “woven” or “non-woven” as appropriate, otherwise a summary table is provided identifying the fabric specification for each fence. (d) Specifications show a maximum 2m spacing of support post. (e) The fence is located at least 2m from base of fill slopes. (f) Specifications (design details) show adequate trenching of fabric.	..... ..... .....

Sediment Control Concentrated Flow		N/A – Not Applicable A – Acceptable Controls Adopted N – measure are not acceptable, or potential problem exists.
Item	Consideration	Assessment
1	Appropriate sediment control standard specified (i.e. Type 2 or Type 3)	.....
2	Location of all sediment control measures clearly shown.	.....
3	The location and operation of sediment control measures will <u>not</u> cause safety issues or flooding of adjacent properties.	.....
5	Appropriate sediment control measures are specified for all “sag” and “on-grade” kerb inlets.	.....
6	Appropriate sediment control measures specified for all field (drop) inlets.	.....
7	Appropriate sediment control measures specified for all culverts and pipe inlets (if required).	.....
8	Type 2 sediment traps (e.g. <i>Rock Filter Dams</i> , <i>Sediment Trenches</i> , <i>Sediment Weirs</i> ): (a) Have adequate up-slope pond area. (b) Have an appropriately sized sediment collection pit. (c) Designed for an appropriate storm frequency.	..... ..... .....
9	Appropriate access is provided to all sediment traps for maintenance and sediment removal.	.....
10	Appropriate sediment control measures are specified for de-watering operations specified (technical notes).	.....

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# Primary Erosion and Sediment Control Plan

NT-2050-15-MP-019.

11	Sediment controls are placed within streams ONLY as a last resort, and only with written approval from all appropriate Regulatory Authorities.	.....
12	Sediment controls placed in and around drainage channels are appropriate for the expected flow conditions.	.....

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## **Appendix F Land Condition Assessment**

# Land Condition Assessment

Velkerri 76 S2 and Kyalla 117 N2 Exploration Program

# Land Condition Assessment

Velkerri 76 S2 and Kyalla 117 N2 Exploration Program

Client: Origin

ABN: 66 007 845 338

Prepared by

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 Reviewed by Abe Francis

### Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
0	20-Sep-2018	August 2018 Land Condition Assessment	Alana Court Principal Scientist	
1	5-Mar-2019	Revised for 2019 program	Alana Court Principal Scientist	
2	16-May-2019	Revision 2 for 2019 program	Alana Court Principal Scientist	
3	27-June-2019	Update following DENR comments regarding recently released <i>Weed Management Planning Guide: Onshore Petroleum Projects June 2019</i>	Alana Court Principal Scientist	

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### Table of Acronyms

Acronym	Meaning
°C	Degrees Celsius
%	Percentage
AAPA	Aboriginal Areas Protection Authority
ALA	Atlas of Living Australia
AS	Australian Standard
BOM	Bureau of Meteorology
CLA	Cambrian Limestone Aquifer
Cth	Commonwealth
DoH	Department of Health (NT)
DotEE	Department of the Environment and Energy (Cmwlth)
DENR	Department of Environment and Natural Resources (NT)
DPIR	Department of Primary Industries and Resource (NT)
DLPE	Department of Lands, Planning and the Environment (NT)
EPA	Environment Protection Authority (NT)
EP##	Exploration Permit (e.g. EP76, EP98 and EP117)
EMP	Environmental Management Plan
EPBC	Environmental Protection and Biodiversity Conservation
ESCP	Erosion and Sediment Control Plan
GPS	Global Positioning Device
Ha	hectare
IBA	Important Bird Area
ILUA	Indigenous Land Use Agreement
Km	Kilometre
km <sup>2</sup>	Square Kilometres
km/hr	Kilometre per hour
LCA	Land Condition Assessment
m	metre
MD	Measured Depth
MNES	Matters of National Environmental Significance
mm	millimetre
NLC	Northern Land Council
NT	Northern Territory
OHS	Occupational Health and Safety
RWA	Restricted Work Area
TO	Traditional Owner
<i>TPWC Act</i>	<i>Territory Parks and Wildlife Conservation Act</i>



Acronym	Meaning
WMP	Weed Management Plan
WoNS	Weed of National Significance

## 1.0 Introduction

### 1.1 Purpose of this Report

AECOM Australia Pty Ltd (AECOM) conducted a land condition assessment (LCA) to support Origin Energy's (Origin) application to the Northern Territory Department of Environment and Natural Resources (DENR) for an Environmental Management Plan (EMP) for various exploration activities.

The purpose of the LCA was to gather baseline information to provide an environmental condition assessment to support the proposed exploration activities to be carried out by Origin at two proposed lease sites during 2019/2020.

### 1.2 Project Boundary

Origin are proposing to undertake a series of activities required to expand their exploration program in the Beetaloo Basin. Origin are targeting two sites for the 2019/2020 exploration program, Velkerri 76 S2 and Kyalla 117 N2. The location and proposed disturbance area are presented in Table 1 and Figure 1.

**Table 1 Proposed Lease Area for Exploration Activities and Disturbance Area**

Exploration Permit	Name	Station	Zone*	Easting	Northing	Disturbance Area (ha)
EP76	Velkerri 76 S2-1	Amungee Mungee	53	435488	8136321	7.2~
EP117	Kyalla 117 N2-1	Hayfield/Shenandoah	53	356175	8137500	9.8~
EP117	Stuart Highway Intersection	Hayfield/Shenandoah	53	332371	8135170	0.5
EP117	Gravel Pit 1	Hayfield/Shenandoah	53	339883	8135005	1.0
EP117	Gravel Pit 2	Hayfield/Shenandoah	53	360366	8135138	1.0
EP117	Gravel Pit 3	Hayfield/Shenandoah	53	362841	8135102	1.0
EP117	Gravel Pit 4 and access track	Hayfield/Shenandoah	53	397906	8136039	1.5
EP117	Gravel Pit 5 and access track	Hayfield/Shenandoah	53	403386	8135809	1.0
EP117	Gravel Pit 6 and access track	Hayfield/Shenandoah	53	405049	8135927	1.0
EP76	Gravel Pit 7	Amungee Mungee	53	435749	8135306	0.5
<b>Total Disturbance Area (Ha)</b>						<b>24.5 ha</b>

\* Universal Transverse Mercator (UTM) geographic coordinate system is Geocentric Datum of Australia (GDA) 94.

~Includes well pad, camp lease, stockpile laydown and access track turnin.

For the purpose of this assessment, the project boundaries were defined as the areas which may be affected by the proposed exploration activities, including:

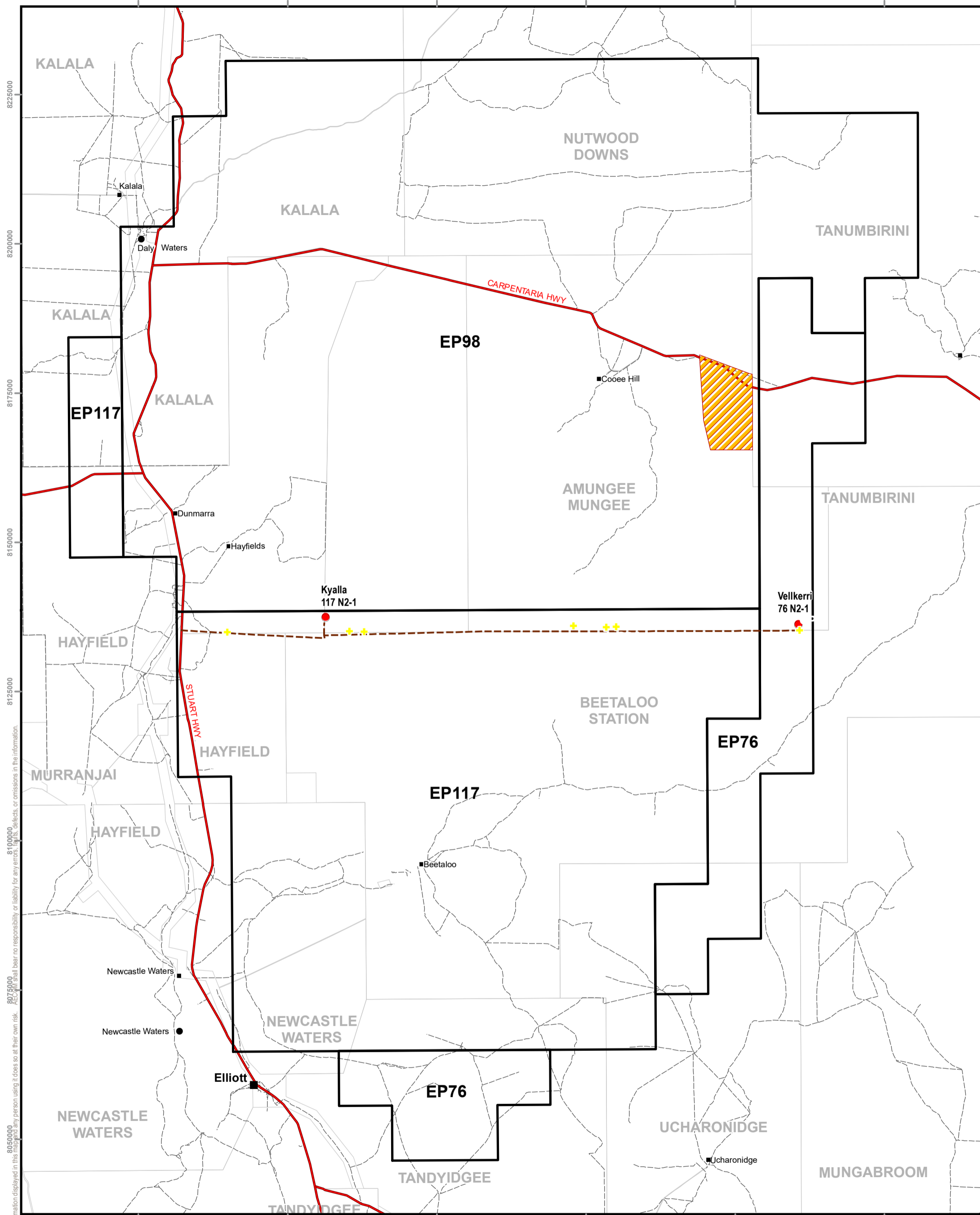
- Construction of a 5.5-ha lease pad at Kyalla 117 N2 and Velkerri 76 S2.
- Construction of a 1.2-ha camp pad at Kyalla 117 N2 and Velkerri 76 S2.
- Construction of a 0.2-ha stockpile area at Kyalla 117 N2 and Velkerri 76 S2.

- Construction of a 0.25-ha helipad and 1-ha wet weather storage area at the Velkerri 76 S2.
- Construct a 650 m long x 8 m wide (0.52-ha) lease pad turn in to Kyalla 117 N2 connecting the proposed lease pad to the existing access track.
- Construct a 1,100 m long x 8 m wide (0.88-ha) lease pad turn in to Velkerri 76 S2 connecting the proposed lease pad to the existing access track.
- Minor intersection upgrade works at the intersection with the Stuart Highway of approximately 0.5-ha in accordance with approved Road Agency approval (2018-0186-D2) and Permit to Work within NT Government Road Reserve.
- Utilise approximately 107 km of existing access track.
- Obtain gravels, as required, for construction of drill pads and sections of the access track at up to seven proposed borrow pits (7 gravel pits up to 1 to 2.1 ha).
- All other activities ancillary to the drilling, stimulation and well testing of an exploration well.

### **1.3 Scope of works**

The scope of work for the LCA involved:

- a review of historical data and reports prepared during the previous Beetaloo onshore oil and gas exploration programs
- a search of the Commonwealth Department of the Environment and Energy (DoTEE) Protected Matters database (27 August 2018)
- a search of the NT Natural Resource Management InfoNet Database (flora and fauna database) (4 September 2018)
- a search of the Atlas of Living Australia (ALA) database for flora and fauna records (2014 and 2016)
- completion of LCA field survey of the proposed exploration lease areas drilling program.
- Preparation of this report.



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GEOCENTRIC DATUM OF AUSTRALIA 94

1:570,000 (when printed at A3)

**LEGEND**

Proposed Wells 2018	Highway	Cadastre
Homestead	Tracks	Permit Areas
Place Name	Access Routes	Bullwaddy Conservation Reserve
Populated Place		
Gravel Pits		

**LOCATION**

**ORIGIN ENERGY RESOURCES LIMITED**  
**2019 Environmental Management Plan**

**Site Location**

PROJECT ID	60480548
CREATED BY	jace.emberg
LAST MODIFIED	20-May-2019
VERSION	1

Data sources:  
 Permit Area, Cadastre - NT Gov 2019.  
 Places, Vegetation - Aust Gov 2019  
 Highways, Roads, Drainage -

**Figure 1**

## 2.0 Assessment Method

### 2.1 Desktop Review

The existing data collected between 2005 and 2016 for the permit areas was mapped based on image interpretation, with ground-truthing of the proposed exploration areas being completed during the field assessment (refer Section 2.2). This information was reviewed prior to the field work to identify the following:

- terrestrial vegetation types and flora and fauna species occurring within the region and with potential to occur within the project area, using existing documents and aerial / satellite imagery.
- terrestrial Commonwealth or Territory listed threatened species or communities identified within the region and with potential to occur within the project area.
- matters of national environmental significance or other matters protected by the Environment Protection and Biodiversity Conservation Act (EPBC Act) that are likely to occur within the project area.
- existing weeds or feral animals listed under the EPBC Act, *Weeds Management Act* or the *Territory Parks and Wildlife Conservation Act* and with potential to occur within the project area.

Table 2 provides a chronological list of reports previously compiled for the exploration permit area between 2004 and 2016, in relation to environmental approvals and management support for petroleum exploration activities in the Beetaloo Basin, NT.

The extent of work undertaken since 2004 has enabled a good understanding of the natural and cultural environment, which has been used in assessing the proposed exploration areas within the Permit Area.

**Table 2 Summary of existing Environmental Assessments and Reports for the Beetaloo Basin (2004 to 2018)**

Date	Report
<b>Sweetpea Petroleum</b>	
Jul- Aug 2004	Baseline land condition assessment
	Site database established
Jul 2005	Exploration EMP finalised and approved
<b>Petrohunter Australia (Partner to Sweetpea)</b>	
Dec 2006	Baseline vegetation assessment
Apr 2007	Drill site assessments
Apr 2007	Annual report
Jun 2007	Update of the existing EMP to include the new Exploration Permit areas
Jul 2007	Drill Site maps
Jul 2007	Supplemental Environmental Management Plan, Drilling Program 2007, Beetaloo Basin, NT
Jul 2007	Soil erosion assessment
Jul 2007	Groundwater quality
July 2007	Emergency Maps
Jul 2007	Environment & Heritage Induction Materials
Aug 2007	Site-based Drilling EMP
<b>Falcon Oil and Gas</b>	
Dec 2010	Drill site condition assessments

Date	Report
Jan 2011	Archaeological survey
March 2011	Site-specific drilling EMP
2011	Falcon Shenandoah 1 Stimulation and Testing Groundwater Monitoring
2011/2012	Shenandoah 1 Re-Entry Environment Plan (EP)
July 2012	EP99 Archaeological Survey, Beetaloo Basin
2013	EP99 Seismic Exploration Environmental Management Plan
2013	Sweetpea 2006 Closeout Environmental Survey
Origin	
2015 and 2016	Beetaloo Basin Environmental and Heritage Assessment and preparation of Approval documentation.
October 2018	Land Condition Assessment

## 2.2 Field assessment and reporting

The LCA of the proposed exploration lease areas, including access tracks, was conducted on 28 to 29 August 2018 by Principal Environmental Scientist, Abe Francis. The survey involved helicopter and pedestrian survey of the proposed exploration lease areas and access tracks and was accompanied by the AECOM Principal Heritage Consultant, Luke Kirkwood and the Department of Environment and Natural Resource (DENR) Regional Weed Officer (Onshore Shale Gas Development), Tahnee Hill.

The LCA used rapid assessment techniques, which allowed for large areas to be surveyed over a relatively small period of time. The helicopter provided a good platform to enable the field team a degree of flexibility by allowing an aerial view of the access tracks and proposed exploration lease areas, as well as the ability to land in otherwise remote locations for ground-truthing.

The primary aim of the LCA was to identify and document site condition prior to the proposed activities occurring in the footprint of the two lease areas and proposed access tracks and inform the preparation of the programs Environmental Management Plan (EMP).

Following the desktop review, AECOM undertook a condition assessment at each of the nominated sites and access tracks to record site-based characteristics, including:

- the presence of drainage lines and the direction of surface flows
- the distance to the nearest sensitive receptors (such as significant vegetation communities or fauna habitats)
- soil characteristics and intactness
- terrestrial vegetation community types (note that the vegetation descriptions would be based on dominant species for each vegetation structural component)
- listed threatened flora species and fauna habitat features, such as hollows, logs and burrows (the fauna habitat quality for each mapped vegetation community type would be assessed)
- incidental fauna sightings
- the presence of weeds and/or feral animals (i.e. indication of scats, tracks, wallows etc.)
- general land use description.

For this assessment, the environmental scouting included a 4-hectare area around the proposed exploration areas, plus an additional 500 m buffer to allow for future flexibility for the proposed Origin exploration activities.

A 250 m buffer each side of an existing access track were scouted to allow for locating camps, gravel pits and water supply bores in the future. Where the access tracks were located on a property boundary, the buffer was 500 m out into the property the track was located on.

It is noted that not all of the nominated areas scouted for the exploration areas and/or access tracks will be affected by site activities, but sufficient size was allowed to provide flexibility in the siting of infrastructure and borrow pits, which in turn can be used to minimise environmental and heritage impacts (e.g. significant tree or habitat avoidance, Sacred Site/archaeological artefact avoidance).

## 3.0 Land Condition Assessment

The results of the LCA and desktop review has been summarised in the following sections. The area covered during the assessment is shown in Figure 2. During the helicopter survey, two sites proposed for exploration activities were ground-truthed, along with the proposed access tracks (refer Section 1.2). Scoping for the gravel pits was also conducted.

### 3.1 Climate

The climate of the Origin permit areas can be described as arid to semi-arid, with rainfall decreasing in frequency and quantity from north to south. The climate is monsoon influenced, with a distinctive wet and dry season experienced through the year. The area experiences a wet season during the summer months between October and March, which is dominated by hot and wet conditions. Whilst the dry season during the winter months experiences mild days and cool nights between May to August. September and April are transitional months, with occasional rainfall. The average annual rainfall in the north of the permit area is listed at 680 mm at Daly Waters. The southern portion of the permit area records an average annual rainfall of 535 mm at Newcastle Waters and 608 mm listed at Elliott. Approximately 90% of the rainfall occurs during the Wet Season, and annual totals show moderate variability from year to year.

The maximum rainfall for the permit area occurs during January and February. Daly Waters experience the highest rainfall in the region at this time, with 165 mm during each month, followed by Elliott (133-164 mm during each month) and Newcastle Waters (125-130 mm during each month). July and August experience the least amount of rainfall and are the driest months across all three weather monitoring sites, ranging from one to four mm of rainfall. The annual rainfall pattern within the area is highly variable and becomes increasingly unpredictable the further move away from the coast. Drought conditions are known to occur in the region once every ten years (Holt and Bertram, 1981).

The land condition assessment was undertaken between 28 and 29 August 2018. The timing of the assessment was such that it fell within the dry season. The Daly Water airstrip station recorded a higher than average rainfall of 590 mm between January to April 2018 wet season compared to the mean rainfall from 1939 to 2018 of 482 mm.

The average annual rainfall experienced across the region (which includes the BOM data from Daly Waters Airstrip and Elliot) is shown in Table 3.

**Table 3 Annual rainfall 2016-2018**

Year	Annual Rainfall (mm)		Months Rain was recorded	
	DW	NW	DW	NW
2016	608	570	12	9
2017	866	607	7	6
2018*	590	270	4	4

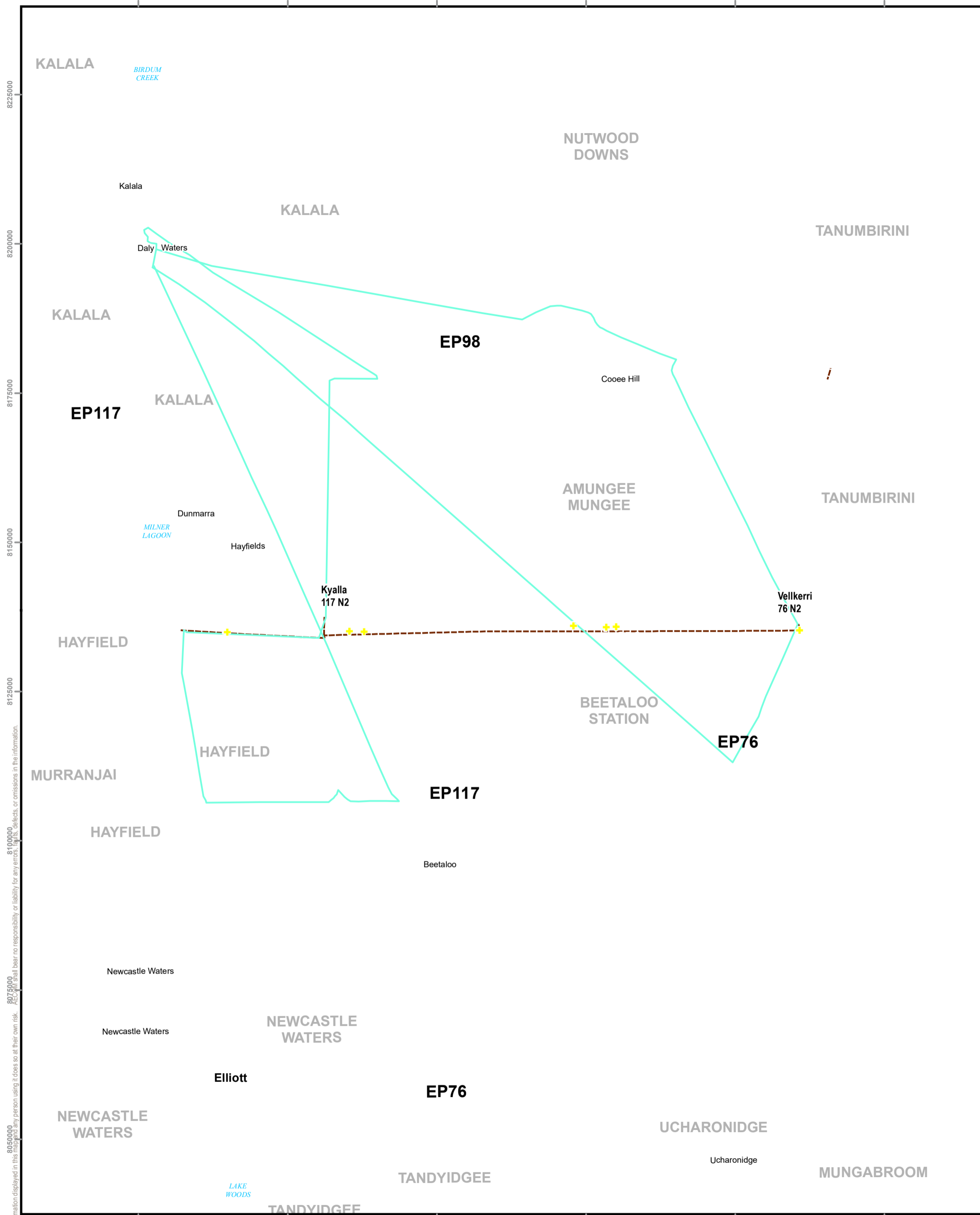
DW – Daly Waters Airstrip, NW – Newcastle Waters.

Data sourced from Bureau of Meteorology, Climate Averages for Station 014626 Daly Waters Airstrip recorded from 1939-2018, Station 015131 Elliot recorded from 1949-2018. \* note 2018 is only current to date (October 2018)


Due to the timing of the LCA occurring at the end of the dry not all species were able to be identified, however sufficient data was able to be captured to obtain a good understanding of the land condition within the proposed lease areas to help inform required management measures for the protection of the environment.

The proposed lease sites and the short access roads are unlikely to be impacted by the onset of the wet season because they are located outside of the adjacent major flow paths and creeklines within the permit area (refer to Section 3.2).





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 <p>www.aecom.com</p> <p>GEOCENTRIC DATUM OF AUSTRALIA 94</p> <p>0 5 10 20 Kilometers</p> <p>1:570,000 (when printed at A3)</p>	<p><b>LEGEND</b></p> <ul style="list-style-type: none"> <li>■ Homestead</li> <li>● Place Name</li> <li>■ Populated Place</li> <li>— Highway</li> <li>— Minor Road</li> <li>--- Tracks</li> <li>- - - Access Tracks</li> <li>□ Cadastre</li> <li>▭ Permit Areas</li> <li>▨ Bullwaddy Conservation Reserve</li> <li>— Helicopter Transects</li> <li>+ Gravel Pits</li> </ul>	<p><b>LOCATION</b></p> <div style="display: flex; justify-content: space-between;"> <div style="width: 60%;"> <p><b>ORIGIN ENERGY RESOURCES LIMITED</b> <b>2019 Environmental Management Plan</b></p> <p><b>Heritage Assessment Transects</b></p> </div> <div style="width: 35%; border-left: 1px solid black; padding-left: 5px;"> <p>PROJECT ID 60480548</p> <p>CREATED BY jace.emberg</p> <p>LAST MODIFIED 20-May-2019</p> <p>VERSION 1</p> </div> </div> <div style="display: flex; justify-content: space-between; margin-top: 10px;"> <div style="width: 60%; font-size: small;"> <p>Data sources: Permit Area, Cadastre - NT Gov 2019. Places, Vegetation - Aust Gov 2019 Highways, Roads, Drainage -</p> </div> <div style="width: 35%; border-left: 1px solid black; padding-left: 5px; text-align: center;"> <p><b>Figure</b> <b>2</b></p> </div> </div>
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### 3.2 Topography, Surface Water and Drainage

The permit area is located within three main topographic zones. These are primarily made up of black soil plains in the south, laterite plains in the north and small sections of bedrock hills in the south west and north east of the permit areas (Tickell, 2003). The proposed lease areas occur within the lateritic plains. The topography of the two sites have low relief and surface water flow ultimately drains in a south and south westerly direction.

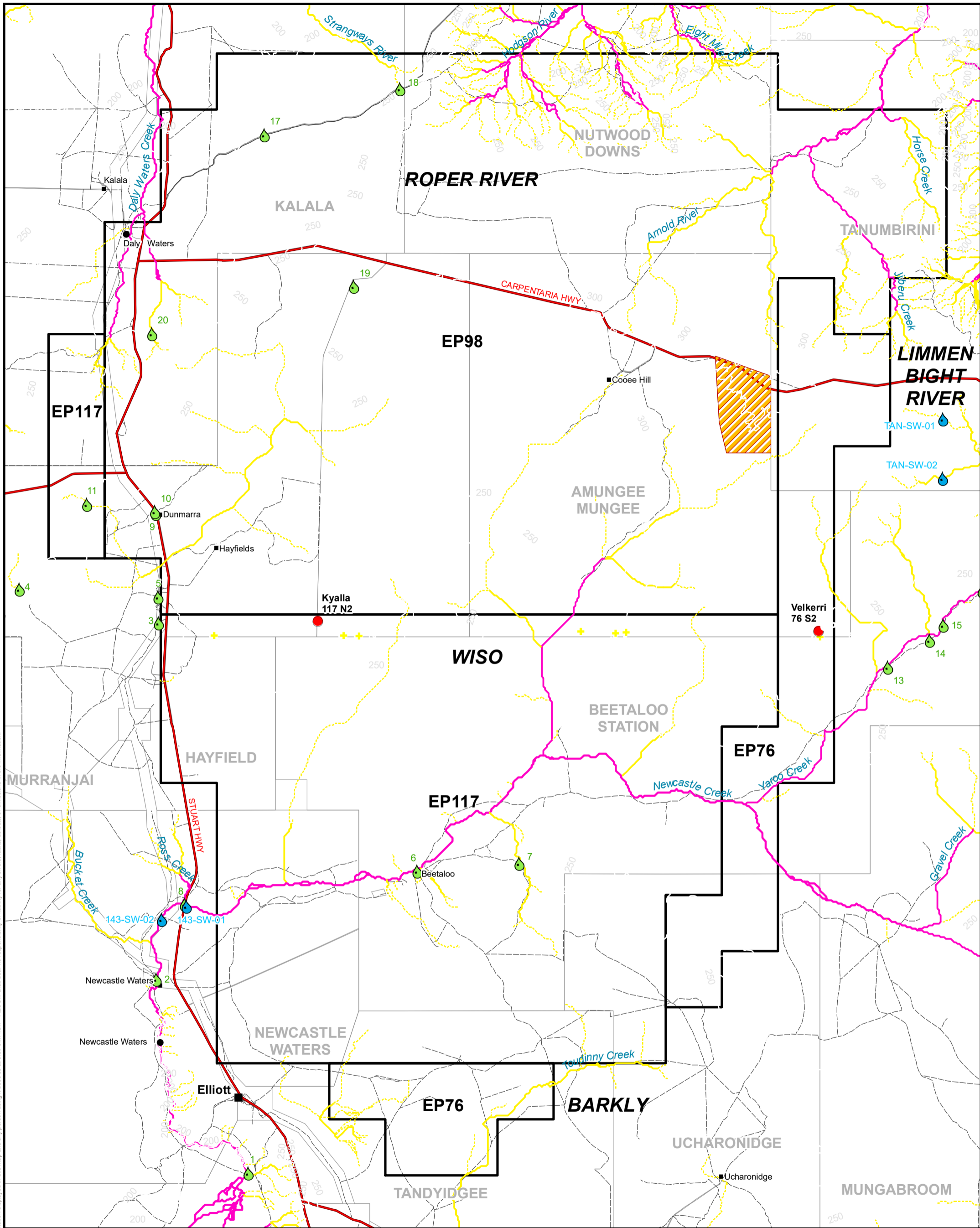
Three main river basins, Roper River Basin to the north, Wiso River Basin in the centre and the Barkly River Basin in the south occur within the exploration permit area (Figure 3). All the proposed lease areas are located within the Wiso River Basin. The Wiso River Basin covers the southern half of EP98 (south of the Carpentaria Highway) and the majority of EP117 and is internally drained by Newcastle Creek and a number of small ephemeral creeks. Newcastle Creek flows into Lake Woods, which is located south of Newcastle Waters Station.

Lake Woods covers an area of inundation of approximately 50,000 ha in normal rainfall years, extending to 80,000 ha in exceptionally wet years, after which it can retain water for several years (AECOM, 2015). Lake Woods is described as a major quasi-permanent surface water body in the region, although some semi-permanent and many ephemeral waterholes are located across the permit area (HLA, 2006b) and is listed as a Site of Conservation Significance by the Department of Environment and Natural Resources (DENR) and is listed on the Directory of Important Wetlands in Australia. Lake Woods is listed as a wetland of national significance in the Directory of Important Wetlands in Australia (DIWA: NT013 Lake Woods). The site meets criteria 1, 2, 3, 4, 5 and includes DIWA wetland types: B1, B6, B10, B13 and B14.

Although Lake Woods is located outside of the Exploration Permit Areas, it is fed principally by surface inflow of Newcastle Creek originating more than 160 km north-east on Amungee Mungee Station (NTG, undated). During the period of inundation, Lake Woods supports over 100,000 waterbirds including internationally significant numbers of Plumed Whistling-Duck. Numerous bird species nest and feed in the diverse wetland habitat, and the conservation group 'Birdlife International' nominated Lake Woods as an 'Important Bird Area' (IBA). The lake also includes the largest area of lignum swamp in the Northern Territory and in tropical Australia (NTG, undated).

Newcastle Creek (Stream Order 4) and a number of small intermittent streams (Stream Order 1 and 2) are located along the proposed access tracks to Velkerri 76 S2 site (refer Figure 3). The streams only flow for a short period during the wet season, with waterholes forming at the beginning of the dry season. If the wet season is poor, the waterholes will often remain dry, whereas, during heavy wet seasons, large areas of the internal drainage systems are flooded. The stream banks are often lined with a scatter of small trees which highlights them from the surrounding plains.

The two proposed lease pad areas are not located within the major flow pathway of Newcastle Creek and the small intermittent streams. During the wetseason it is likely the region would experience widespread surface flooding, to a depth of 30 cm, which has previously been identified by debris being collected on fence lines (HLA, 2005).



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**LEGEND**

- Proposed Well 2018
- Homestead
- Place Name
- Populated Place
- Contours
- + Gravel Pits
- Surface Water 2007
- Surface Water 2015
- DLRM Surface Water
- Highway
- Minor Road
- Tracks
- Bullwaddy Conservation Reserve
- Cadastre
- Permit Areas
- River Basins
- Barkly
- Limmen Bight River
- Roper River
- Wiso
- Stream Order Intermittent Streams 1
- 2
- Creeks 3
- 4
- Rivers 5
- 6
- 7

**LOCATION**

**Scale:** 1:570,000 (when printed at A3)

**Scale Bar:** 0, 5, 10, 20 Kilometers

**Geographic Information:** GEOCENTRIC DATUM OF AUSTRALIA 94

**ORIGIN ENERGY RESOURCES LIMITED**  
**Environmental Management Plan 2019**

**Surface Water and Stream Order of Permit Area**

PROJECT ID: 60480548  
 CREATED BY: jace.emberg  
 LAST MODIFIED: 20-May-2019  
 VERSION: 1

**Figure 3**

### 3.3 Land System

Land systems are defined because of their distinct differences from the surrounding areas and by the recurring pattern of geology, topography, soils and vegetation. Land system mapping for the permit area developed is a compilation of the Northern Land Systems (scale 1:250 000) and the Southern Land Systems (scale 1:1 000 000) (Department of Land Resource Management 2013). The data set is made up of the following:

- *Land Systems of the Northern Part of the Northern Territory* is an amalgamation of 16 existing Land System surveys with modifications to some of the original interpretations. This land system dataset is the Northern Territory contribution to Australian Soil Resource Information System (ASRIS) national soils database at scale 1:250,000.
- *Land Systems of the Southern Part of the NT* is a compilation of three existing land system surveys and the Atlas of Australian Soils (scale 1:2,000,000). It covers the southern part (approx 70%) of the Northern Territory. Published maps were made digital and edited to accommodate overlaps, gaps and mismatching boundaries. Where possible, the land system descriptions have been extrapolated into areas covered by the broader scale Atlas mapping.

Using the available information, there are 22 different land systems located within the exploration permit areas. The Velkerri 76 S2 and Kyalla 117 N2 proposed lease area and seven proposed gravel pits all occur within the Beetaloo Land System which is characterised by:

- gently undulating lateritic plains and rises
- lateritic red earths and lateritic podzolic soils
- *Acacia shirleyi* (Lancewood) forest.

### 3.4 Soils

The dominant soils encountered within the permit area have been derived from ancient rock formations and ancestral soils that were formed during the earlier weathering cycles. The soils are deeply weathered and leached (Orr and Holmes, 1984). The soils in the permit area have been influenced by:

- past wetter conditions that formed relict Tertiary plains which comprise highly leached and lateritic soils
- extensive areas of Post-Tertiary Alluvia on which a variety of mature soils formed
- the dissected hilly country that is dominated by skeletal soils or rocky outcrops
- a range of parent materials of residual soils, ranging from basic volcanic and highly calcareous rocks to granitoid rocks and sandstones (Christian *et al*, 1951).

The lateritic plains, located within the permit area, are classed as very strongly leached soils of the Tertiary land surface. The three main soil types located within the permit area, include:

- **Tertiary Lateritic Red Earths**, which occur on the gently undulating topography. The soil profile can be described as:
 

<b>A-Horizon</b>	Grey-brown sandy loam
<b>B-Horizon</b>	Reddish brown sandy clay loam
<b>C-Horizon</b>	Red-brown to red light clay, overlying heavy ferruginous gravel and massive laterite
- **Tertiary Lateritic Red Sands**, which occur on gently undulating to undulating topography of the Tertiary Lateritic Plain, formed from sandstones and complex parent materials of the deep sandy soils. The soil profile can be described as:
 

<b>A-Horizon</b>	Grey-brown to brown sand
<b>B-Horizon</b>	Brown sand

**C-Horizon** Red-brown to yellow-brown sand overlying pisolitic ferruginous gravel and massive laterite. Altered colouring of highly siliceous parent sandstone is only evident in the mottled and pallid zones.

- **Tertiary Lateritic Podzolic Soils**, formed on the gently undulating topography over a variety of rocks. These soils are located in the northern section of the Barkly Basin. The soil profile can be described as:

**A-Horizon** Grey sand

**B-Horizon** Yellowish-grey sand

**C-Horizon** Yellow-grey sandy loam with ferruginous gravel overlying massive laterite, mottled and pallid zones.

Geotechnical investigations have confirmed the proposed lease sites consist of red silty sand with some gravel pieces. Although Velkerri 76 S2 test result indicated a higher percentage of gravel content compared to Kyalla 117 N2 both sites should be characterised as red silty sand. The surface soils collected during the field survey indicated the soils were slightly acidic (pH range of 5.0 to 6.2) across the permit area. A dispersion test was also undertaken on the samples which indicated that the soils were non-dispersive and maintained their shape when submerged in water. Results from the soil testing is provided in Appendix A.

There are also small sections of the proposed access track that may traverse through Black soil plain country. Black Soil Plains are located within the Barkly Tablelands, including EP76, the southern part of EP117 and a small section of EP98. The soils usually crack widely in the upper profile upon drying and have a loose, self-mulching surface. The soils are neutral to alkaline, calcareous and commonly have depths to one metre (Fisher, 2001). The cracking clay soils occur mostly on flat or gently undulating plains ('downs') and are associated with the exposure and weathering of sedimentary or basic volcanic rocks. The Black soils also occur on the more recent depositional landscapes in the form of alluvial clays associated with drainage lines and major river systems.

### 3.4.1 Erosion Susceptibility

Soil erosion susceptibility varies throughout the permit area, dependent upon the soil types, slope and extent of ground disturbance. Apart from the erosive impact of climatic conditions, soil erosion is influenced mainly by the inherent properties of the soils and the processes which occurred during the formation of the landscapes (Aldrick and Wilson, 1992).

Erosion will occur in the permit area if the land is used beyond its capacity, as is seen if land is overstocked or vehicle movements not controlled, for example. The location of proposed lease areas has been examined on the ground, to determine the risk of erosion occurring. Factors considered include the following.

- Soil type – soils with higher clay content are prone to generation of bulldust and are easily eroded by wind and water. Gravelly soils tend to be more robust to disturbance on the scale expected during the exploration program. Both sites reported a soil type of red silty sand.
- Slope – the slope of the site will determine the risk of erosion during rainfall events, with steeply inclined areas a higher risk than small undulations in the landform. All the proposed lease sites were in very flat (low relief) with a slope of <1%. During the program, the crossings of the access track on the small ephemeral streams and Newcastle Creek will require additional controls.
- Aspect – the position of the access track and pads in relation to the direction of the contour should be considered and creation of tracks across (as opposed to parallel with) the contour should be avoided.
- Rainfall – Table 4 present the erosion risk rating based on average monthly rainfall using the rating system provided in the IECA (2008) Table 4.4.2 for Daly Waters. The construction activities for all exploration activities is proposed to be commence following the wet season from April 2019 onwards. Most of the soil disturbance activities will be completed prior to the onset of the wet season in November 2019. As such, based on rainfall during the construction period, the overall risk of erosion is considered very low for the Velkerri 76 S2 and Kyalla 117 N2 sites.

**Table 4 Erosion Risk Rating based on average monthly rainfall at Daly Waters**

-Item	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	165.4	165.4	120.1	23.6	5.0	5.6	1.5	1.7	4.9	22.5	59.4	110
Erosion Risk*	H	H	H	VL	VL	VL	VL	VL	VL	VL	M	H

\* **E** = Extreme (>225 mm); **H** = High (100+ to 225 mm); **M** = Moderate (45+ to 100 mm); **L** = Low (30+ to 45 mm); **VL** = Very Low (0 to 30 mm)

Based on the sites descriptions and the results from the soil samples, the erosion risk for the proposed lease areas is considered None/Slight erosion risk. This was confirmed during the field survey in August 2018 which reported no evidence of erosion within the proposed lease areas.

Certain sections of the proposed access tracks are likely to encounter more erosion susceptible soils, such as the access track to the southern sites and where streams and Newcastle Creek are crossed (refer Section 3.2). Mitigation measures will need to be established to minimise the risk for erosion along the track and are stabilised leading up to the wet season.

Overall, the main issues to be managed in relation to soils during exploration activities in the permit areas include:

- the generation of bull dust along the access tracks. Noting previous observations have indicated bull dust had formed where the surface crust had been disturbed and then subjected to repeated ground disturbance (AECOM 2015). This was primarily in grassland areas.
- The formation erosion gullies along inappropriately placed tracks and fence lines, where a slope was present. Scolding to bedrock has previously been observed in other areas of the permit, as well as pooling of water in areas of compaction and subsidence.

### 3.5 Biological Environment

#### 3.5.1 Vegetation Communities

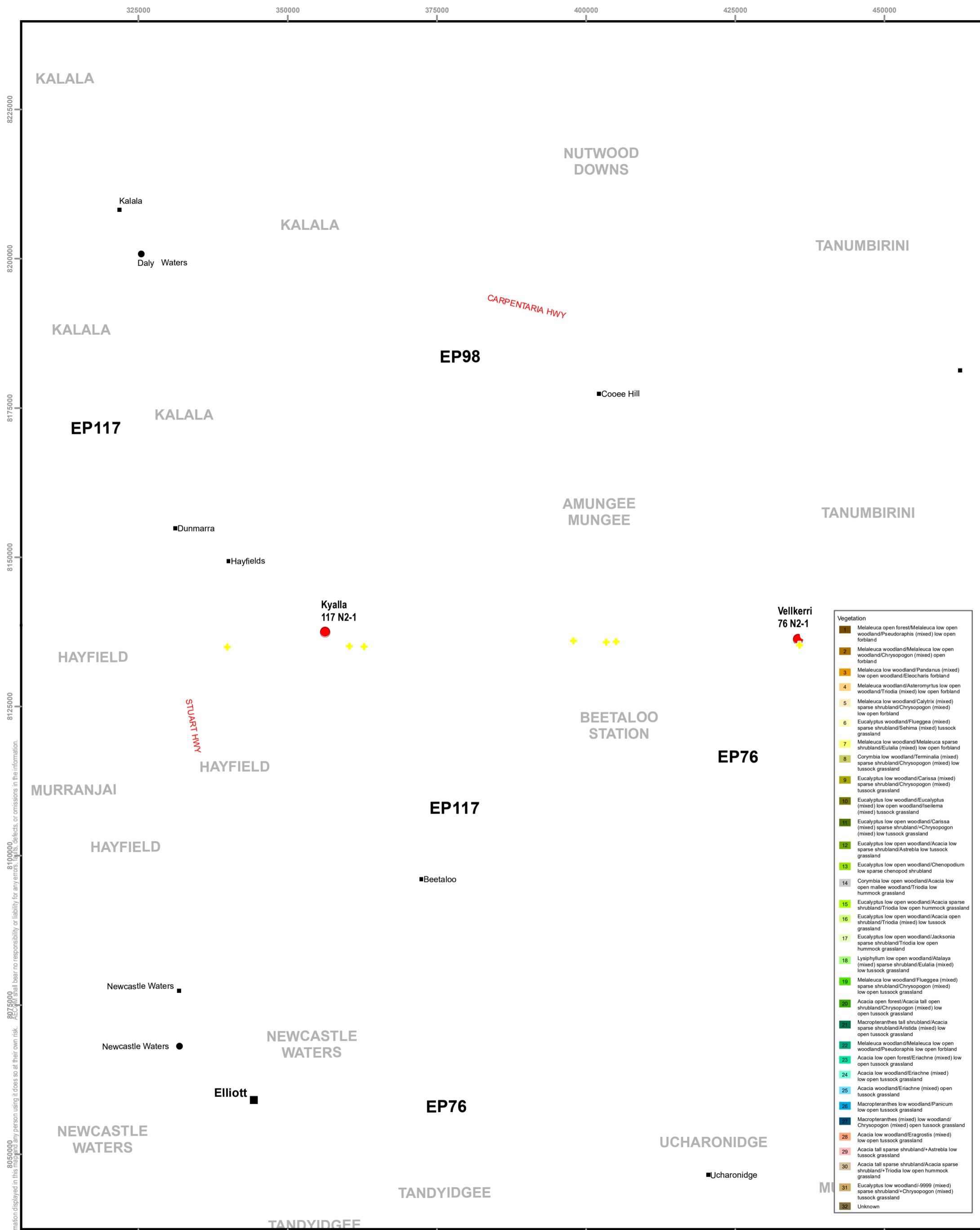
The Interim Biogeographic Regionalisation of Australia is a nationally recognised ecosystem classification system (Environment Australia, 2000). Bioregions are large, geographically distinct ecosystems that are distinguished by broad physical and biological characteristics, which can be further classified into Subregions. These regions and subregions are used as the basis for regional comparisons and conservation of flora and floristic communities.

Of the 85 bioregions mapped nationally, 20 occur within the Northern Territory and only two within the Origin permit areas, the Sturt Plateau bioregion and the Mitchell Grass Downs bioregion. The 2018 proposed lease sites all fall within the Sturt Plateau Bioregion which comprises undulating plains on sandstone, with predominantly neutral sandy red and yellow earth soils. Dominant vegetation associations included extensive areas of Lancewood (*Acacia shirleyi*) - Bullwaddy (*Macropteranthes kekwickii*) vegetation. Land condition in the bioregion is moderate to good but is threatened by impacts from weeds, feral animals, pastoralism and changed fire regimes.

Vegetation communities within the permit areas have been ground-truthed during baseline assessments in 2004, 2006 (HLA, 2006; 2006c), 2010, 2014, 2016 (AECOM, 2011; 2014; 2016) and more recently in August 2018, along with assessments of weeds, habitat, erosion and land condition.

Kyalla 117 N2 vegetation community including the turn-in is described as *Corymbia* spp open woodland with mixed *Terminalia* spp. shrubland over low tussock grassland (*Triodia bitextura*). Whereas, Velkerri 76 S2 vegetation community is described as *Eucalyptus/Corymbia* spp. low open woodland with *Iseilema* spp. mixed tussock grassland. Directly to the west and south of Velkerri 76 S2 there is a large stand of Bullwaddy and Lancewood vegetation community which the proposed access track previously traversed. Following site survey the project has determined that the access track will now be diverted around the Lancewood/Bullwaddy stand to minimise impact on a known sensitive vegetation community.

Figure 4 provides vegetation communities across the entire permit area, while Figure 5 and Figure 6 provides the vegetation communities on the proposed lease sites, Kyalla 117 N2 and Velkerri 76 S2.



Vegetation	
1	Melaleuca open forest/Melaleuca low open woodland/Pseudoraphis (mixed) low open formland
2	Melaleuca woodland/Melaleuca low open woodland/Chrysopogon (mixed) open formland
3	Melaleuca low woodland/Pandanus (mixed) low open woodland/Eleocharis formland
4	Melaleuca woodland/Asteromyrtus low open woodland/Trodia (mixed) low open formland
5	Melaleuca low woodland/Calytrix (mixed) sparse shrubland/Chrysopogon (mixed) low open formland
6	Eucalyptus woodland/Flueggea (mixed) sparse shrubland/Sehima (mixed) tussock grassland
7	Melaleuca low woodland/Melaleuca sparse shrubland/Eulalia (mixed) low open formland
8	Corymbia low woodland/Terminalia (mixed) sparse shrubland/Chrysopogon (mixed) low tussock grassland
9	Eucalyptus low woodland/Carissa (mixed) sparse shrubland/Chrysopogon (mixed) tussock grassland
10	Eucalyptus low woodland/Eucalyptus (mixed) low open woodland/Seilema (mixed) tussock grassland
11	Eucalyptus low open woodland/Carissa (mixed) sparse shrubland/Chrysopogon (mixed) low tussock grassland
12	Eucalyptus low open woodland/Acacia low sparse shrubland/Astrebla low tussock grassland
13	Eucalyptus low open woodland/Chenopodium low sparse chenopod shrubland
14	Corymbia low open woodland/Acacia low open mallee woodland/Trodia low hummock grassland
15	Eucalyptus low open woodland/Acacia sparse shrubland/Trodia low open hummock grassland
16	Eucalyptus low open woodland/Acacia open shrubland/Trodia (mixed) low tussock grassland
17	Eucalyptus low open woodland/Jacksonia sparse shrubland/Trodia low open hummock grassland
18	Lysiphylum low open woodland/Atalaya (mixed) sparse shrubland/Eulalia (mixed) low tussock grassland
19	Melaleuca low woodland/Flueggea (mixed) sparse shrubland/Chrysopogon (mixed) low open tussock grassland
20	Acacia open forest/Acacia tall open shrubland/Chrysopogon (mixed) low open tussock grassland
21	Macropteranthes tall shrubland/Acacia sparse shrubland/Aristida (mixed) low open tussock grassland
22	Melaleuca woodland/Melaleuca low open woodland/Pseudoraphis low open formland
23	Acacia low open forest/Eriachne (mixed) low open tussock grassland
24	Acacia low woodland/Eriachne (mixed) low open tussock grassland
25	Acacia woodland/Eriachne (mixed) open tussock grassland
26	Macropteranthes low woodland/Panicum low open tussock grassland
27	Macropteranthes (mixed) low woodland/Chrysopogon (mixed) open tussock grassland
28	Acacia low woodland/Eragrostis (mixed) low open tussock grassland
29	Acacia tall sparse shrubland/Astrebla low tussock grassland
30	Acacia tall sparse shrubland/Acacia sparse shrubland/Trodia low open hummock grassland
31	Eucalyptus low woodland/9999 (mixed) sparse shrubland/Chrysopogon (mixed) tussock grassland
32	Unknown

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GEOCENTRIC DATUM OF AUSTRALIA 94

1:570,000 (when printed at A3)

**LEGEND**

- Proposed Wells 2019
- Homestead
- Place Name
- Populated Place
- Highway
- Permit Areas
- ▨ Bullwaddy Conservation Reserve
- ⊕ Gravel Pits

**LOCATION**

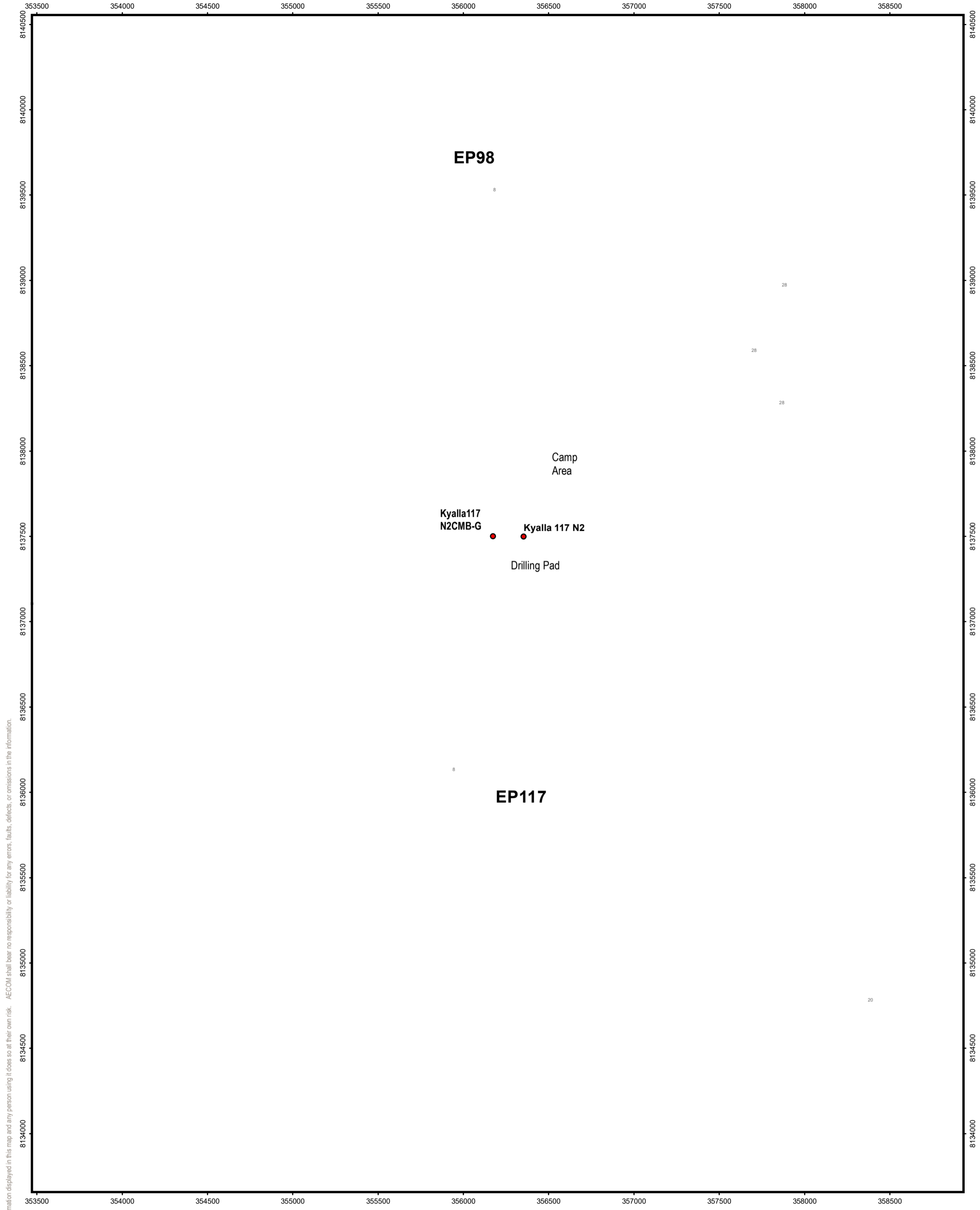
Data sources:  
 Permit Area, Cadastre - NT Gov 2019.  
 Places, Vegetation - Aust Gov 2019  
 Highways, Roads, Drainage -

**ORIGIN ENERGY RESOURCES LIMITED**  
**2019 Environmental Management Plan**

**Vegetation Communities**

PROJECT ID	60480548
CREATED BY	jace.emberg
LAST MODIFIED	20-May-2019
VERSION	1

**Figure 4**



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**LEGEND**

- KYA117-N2 CMB-G
- Proposed 2019
- Drill Pad and Services Location
- Permit Areas

**Vegetation Community**

- Acacia low woodland/Eragrostis (mixed) low open tussock grassland
- Acacia open forest/Acacia tall open shrubland/Chrysopogon (mixed) low open tussock grassland
- Corymbia low woodland/Terminalia (mixed) sparse shrubland/Chrysopogon (mixed) low tussock grassland

**LOCATION**



Data sources:  
 Permit Area, Cadastre - NT Gov 2019.  
 Places, Vegetation - Aust Gov 2019  
 Highways, Roads, Drainage -

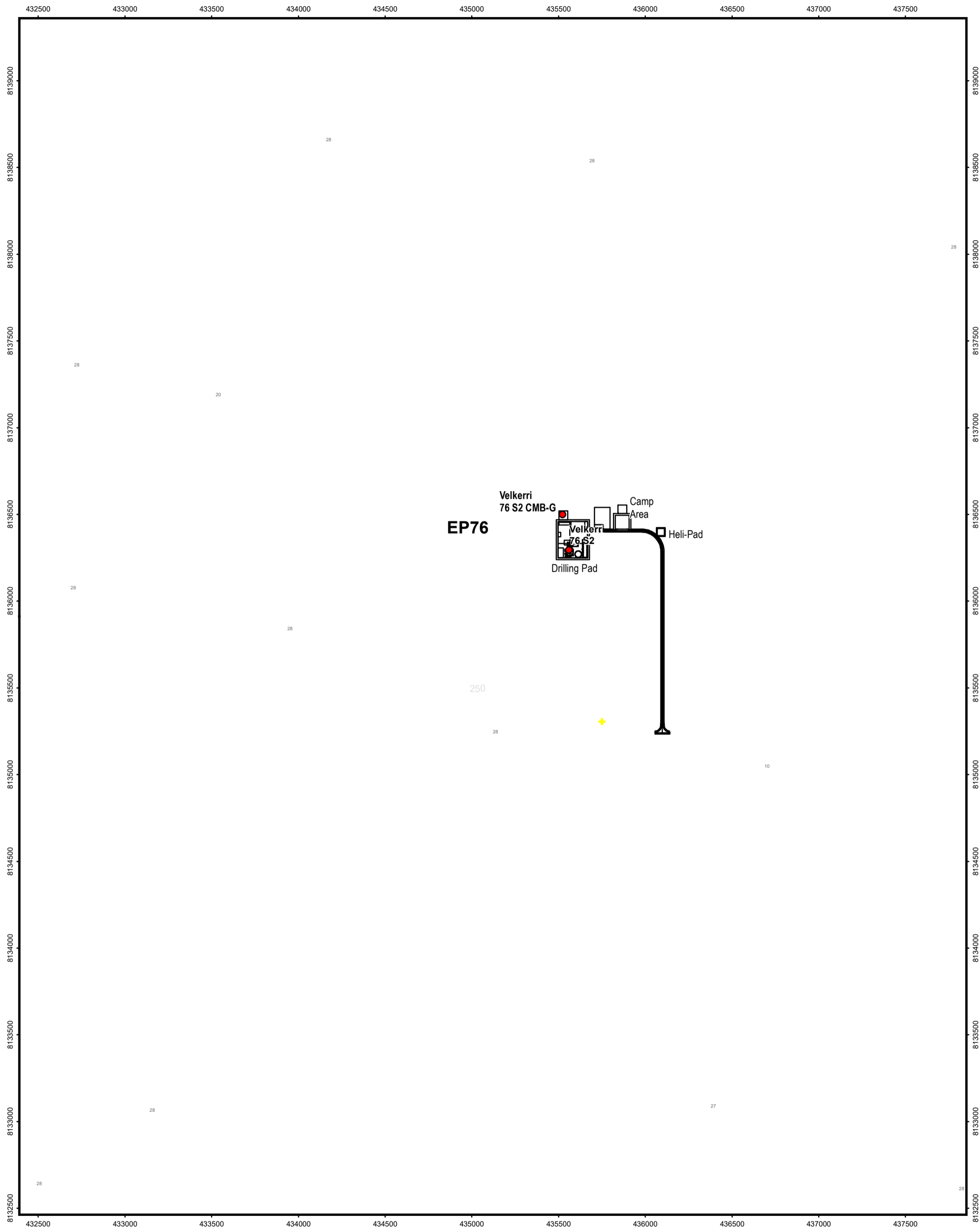
**ORIGIN ENERGY RESOURCES LIMITED  
 2019 Environmental Management Plan**

**Kyalla 117 N2-1  
 Vegetation Community**


PROJECT ID	60480548
CREATED BY	jace.emberg
LAST MODIFIED	04-Mar-2019
VERSION	1

**Figure  
 5**






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Projection: GDA94 MGA Zone 53

0 50 100 200  
Meters

1:20,000 (when printed at A3)



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**LEGEND**

- Velkerri76 S2 CMB-G
- Velkerri76 S2
- Permit Areas
- Tracks
- Contours
- + Gravel Pits

**Vegetation**

- Acacia low woodland/Eragrostis (mixed) low open tussock
- Acacia open forest/Acacia tall open shrubland/Chrysopogon (mixed) low open tussock grassland
- Eucalyptus low woodland/Eucalyptus (mixed) low open woodland/Iseilema (mixed) tussock grassland
- Macropteranthes (mixed) low woodland/Chrysopogon (mixed) open tussock grassland

**LOCATION**



Data sources:  
Permit Area, Cadastre - NT Gov 2019.  
Places, Vegetation - Aust Gov 2019  
Highways, Roads, Drainage - StreetPro 2019

**ORIGIN ENERGY RESOURCES LIMITED**

**2019 Environmental Management Plan**

**Velkerri 76 S2-1**

PROJECT ID	60480548
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VERSION	1

Figure  
6

The approximate 107 km of the existing access track is predominantly surrounded by the same vegetation unit as Kyalla 117 N2, with patches of Bullwaddy and Lancewood, including at the proposed entrance off the Stuart Highway and surrounding some of the Gravel Pits. In addition, there are some areas of minor stands of Melaleuca low open wood and mixed acacia woodlands.

Previous exploration activities in the permit area provided some understanding on how the vegetation communities regenerated following clearing and rehabilitation. The rehabilitation monitoring following previous exploration programs were undertaken during 2007 and again in 2013 (HLA, 2007 and 2013). It was noted that in the first year the success of rehabilitation was greatest in communities with grassland understory (primarily due to annual grass growth), whereas woodlands (mainly Lancewood and Bullwaddy) showed low levels of natural regeneration. By 2013, six years after disturbance the origin seismic lines through the Lancewood were such that there was almost no difference in the canopy height to the surrounding Lancewood communities.

The vegetation types described for the identified gravel pit locations are described in Table 5.

**Table 5 Gravel Pit Vegetation Description**

Gravel Pit	Vegetation Description
GP1	Corymbia low woodland/Terminalia (mixed) sparse shrubland/Chrysopogon (mixed) low tussock grassland
GP2	Acacia open forest/Acacia tall open shrubland/Chrysopogon (mixed) low open tussock grassland
GP3	Acacia open forest/Acacia tall open shrubland/Chrysopogon (mixed) low open tussock grassland
GP4	Macropteranthes (mixed) low woodland/Chrysopogon (mixed) open tussock grassland
GP5	Corymbia low woodland/Terminalia (mixed) sparse shrubland/Chrysopogon (mixed) low tussock grassland
GP6	Corymbia low woodland/Terminalia (mixed) sparse shrubland/Chrysopogon (mixed) low tussock grassland
GP7	Acacia low woodland/Eragrostis (mixed) low open tussock grassland

The vegetation throughout the permit area during the August 2018 survey appeared in very good condition with minimal impacts from grazing, fire and erosion.

### 3.5.2 Flora

A total of 805 plant species have been recorded within the wider region, during the August 2018 survey 10 dominant flora species were identified at Kyalla 117 N2 and Velkerri 76 S2 (Appendix B). As the survey was conducted during the late dry season, grasses and other annual species were difficult or impossible to identify due to the lack of inflorescence or because they had already died-back.

No Commonwealth or NT threatened plant species were identified as occurring by the Protected Matters Searches (refer Appendix C). One species, the prostrate, herbaceous vine *Ipomoea argillicola*, is listed as Near Threatened under Section 29 of the *Territory Parks and Wildlife Conservation Act 2000* (TPWC Act) and could potentially occur in the project sites, although has not been reported in previous and current surveys. NT flora data base shows that this species has been recorded from the Bullwaddy Conservation Reserve and at locations surrounding the area in previous searches (AECOM, 2015).

The region supports fragmented stands of Bullwaddy, which is listed under the TPWC Act as 'Least Concern', which refers to species that are either widespread or common and cannot be categorised as Critically Endangered, Endangered, Vulnerable, Near Threatened or Data Deficient. However, Bullwaddy is significant in terms of the habitat it provides for a range of native species. The extent of Bullwaddy in the permit area is far more extensive than that indicated by the NT Herbarium records.

### 3.5.3 Weeds

Weeds remain an increasing threat to the Barkly region's natural assets. This threat is not new and considerable time and effort has already been invested in weed management across the region (Department of Land Resource Management, 2015).

Figure 7 and Table 6 provides a list of weed species that are known to occur or likely to occur within the wider exploration Permit Areas.

This information is based on:

- Mapping data provided by the Weed Management Branch, DENR.
- *Weed Management Planning Guide: Onshore Petroleum Projects* (DENR, June 2019).
- Guidelines for the *Management of the Weeds of Beetaloo 2018* (DLRM et al 2018).
- Department of the Environment and Energy (DotEE) EPBC Act Protected Matters Report database.
- Previous data collected by AECOM in the permit area.

**Table 6 NT listed weeds known of likely to occur within the Permit Area**

Scientific Name	Common Name	Status	Data Source
<i>Acacia nilotica</i>	Prickly Acacia	Class A and C, WoNS	Weed Management Branch – Mapping data DotEE Protected Matters Report
<i>Alternanthera pungens</i>	Khaki Weed	Class B and C	DLRM databases (DLRM et al 2018)
<i>Andropogon gayanus</i>	Gamba Grass	Class A and C, WoNS	Weed Management Branch – Mapping data
<i>Azadirachta indica</i>	Neem	Class B and C	Weed Management Branch – Mapping data
<i>Cenchrus ciliaris</i>	Buffel Grass	Not declared in NT	DotEE Protected Matters Report
<i>Cenchrus echinatus</i>	Mossman River Grass	Class B and C	DLRM databases (DLRM et al 2018)
<i>Datura ferox</i>	Fierce Thornapple	Class A and C	DLRM databases (DLRM et al 2018)
<i>Hyptis suaveolens</i>	Hyptis	Class B and C	Weed Management Branch – Mapping data DLRM databases (DLRM et al 2018)
<i>Jatropha gossypifolia</i>	Bellyache Bush	Class B and C, WoNS	Weed Management Branch – Mapping data DLRM databases (DLRM et al 2018) DotEE Protected Matters Report
<i>Parkinsonia aculeate</i>	Parkinsonia	Class B and C, WONS	Weed Management Branch – Mapping data DLRM databases (DLRM et al 2018) DotEE Protected Matters Report

Scientific Name	Common Name	Status	Data Source
<i>Prosopis pallida</i>	Mesquite	Class A and C, WONS	Weed Management Branch – Mapping data DLRM databases (DLRM <i>et al</i> 2018)
<i>Sida acuta</i>	Spinyhead sida	Class B and C	Weed Management Branch – Mapping data
<i>Sida cordifolia</i>	Flannel Weed	Class B and C	Weed Management Branch – Mapping data DLRM databases (DLRM <i>et al</i> 2018)
<i>Sida rhombifolia</i>	Paddy's Lucerne	Class B and C	DLRM databases (DLRM <i>et al</i> 2018)
<i>Tamarix aphylla</i>	Athel pine	Class B and C, WONS	Weed Management Branch – Mapping data
<i>Themeda quadrivalvis</i>	Grader Grass	Class B and C, WoNs	Weed Management Branch – Mapping data
<i>Tribulus terrestris</i>	Caltrop	Class B and C	DLRM databases (DLRM <i>et al</i> 2018)
<i>Xanthium occidentale</i>	Noogoora Burr	Class B and C	Weed Management Branch – Mapping data DLRM databases (DLRM <i>et al</i> 2018)

Note: Declarations under the Northern Territory Weeds Management Act 2013:

- a Class A weed is to be eradicated
  - a Class B weed is to have its growth and spread controlled
  - a Class C weed is not to be introduced to the NT.
- \* All Class A and B weeds are also Class C.

They survey undertaken in August 2018 and June 2019 of the proposed exploration lease areas did not identify any weed species. This suggests that the habitat condition in the areas of the proposed sites and surrounding areas were good.

Previous surveys within the Permit Area in 2014, 2015, 2016, 2018 and 2019 of drill sites and access tracks have also found that the proposed areas had a low number of weed species which suggests the habitat condition was fairly high in and around the Permit Area. Specifically, three listed species, *Parkinsonia aculeate* (Parkinsonia), *Hyptis suaveolens* (Hyptis) and *Calotropis procera* (Rubber Bush) have been recorded.

Rubber Bush (Plate 1) was recorded during the follow up survey conducted June 2019. In addition, Wild Passionfruit (*Passiflora foetida*) (Plate 2) and Stylo (*Stylosanthes* sp.) were observed throughout the area but are not listed as weed under NT legislation.

Rubber Bush (Class B and C) has previously been recorded in close proximity to the Beetaloo access track in 2016 and was also noted during the 2019 survey at the start of the Stuart Highway intersection (Plate 1). This was a patch of adult plants with seedpods.

Parkinsonia is considered a Weed of National Significance (WoNS), which are weed species that are the focus of national management programs for restricting their spread and/or eradicating them from parts of Australia. This species was not recorded within the proposed 2019 exploration area.

It is possible that additional species are present but were present in low abundance or difficult to identify due to stage of growth.



**Plate 1 Rubber Bush near the Stuart Highway Intersection on Hayfield/Shenandoah**



**Plate 2 Wild Passionfruit also located near the Stuart Highway Intersection.**

These weed species surveyed within the Permit Area and their corresponding Northern Territory *Weeds Management Act 2013* declarations are listed in Table 7.

**Table 7** Species found within the permit area

Scientific Name	Common Name	Declaration	Where located
<i>Hyptis suaveolens</i>	Hyptis	Class B and C	Beetaloo access track Access track to Velkerri 98-E1-1 site Stuart Highway
<i>Parkinsonia aculeate</i>	Parkinsonia	Class B and C, WONS	Beetaloo access track
<i>Calotropis procera</i>	Rubber bush	Class B and C	Close proximity to the Beetaloo access track. At beginning of 2019 Access Track near Stuart Highway Intersection

In addition to these 18 species a range of annual grass weeds are known to occur along road corridors throughout the region. Hyptis (Plate 3), and Buffel Grass (*Cenchrus ciliaris*) (Plate 4) were recorded along the Stuart Highway within the NTG Road Reserves. Buffel Grass is of concern due to its invasive nature and ability to alter ecosystem function. Buffel Grass however was introduced and cultivated for livestock feed and is useful in soil stabilisation.



**Plate 3** Hyptis at a road side truck stop on the Stuart Highway



**Plate 4** Buffel Grass on top of a Table Drain along Stuart Highway

The *Guidelines for the Management of the Weeds of Beetaloo 2018* (DLRM et al 2018), also identifies a number of introduced plants that have previously been recorded within the proposed permit areas and have been identified as problem weeds in one or more locations across Northern Australia. It is noted that these are not listed under the NT *Weeds Management Act* but could be of concern elsewhere in Australia. Understanding the potential weeds likely to occur within the Permit Area is particularly important when proposed activities include transporting machinery and equipment during the construction process.

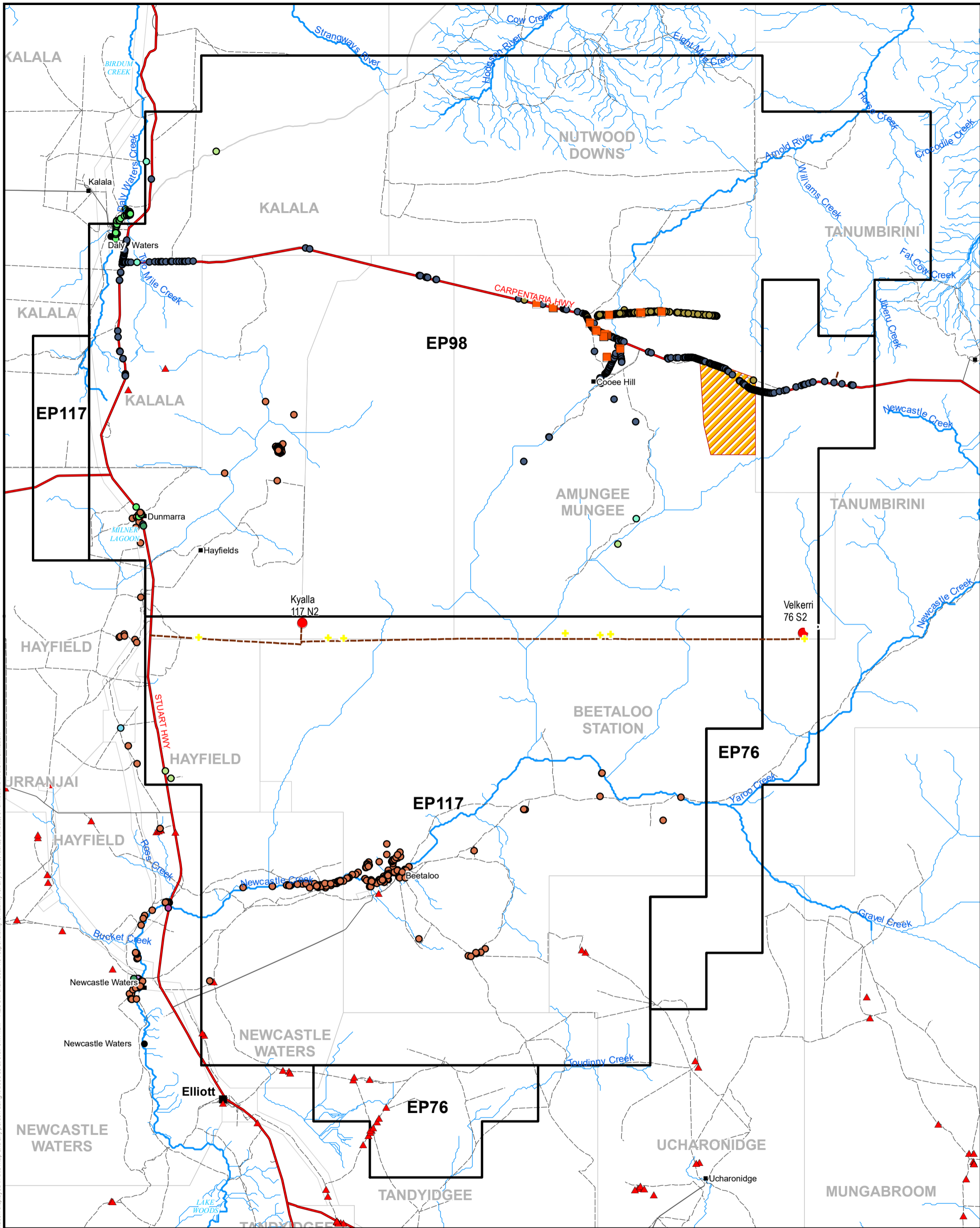
The *Barkly Regional Weed Management Plan* provides additional information on regional weed management priorities and management actions to support landholders in their obligations to manage weeds on their land (DLRM, 2015).

This plan includes a list of alert weed species. These species are not yet naturalised in the region but have the potential to have a high level of impact to the region should they become established. The likelihood of the species naturalising and spreading in the region is perceived to be high (DLRM, 2015).

The alert species identified the *Barkly Regional Weed Management Plan* are listed Table 8. If found the program EMP requires the Weed Management Branch to be contacted for identification and disposal.

**Table 8** Alert species identified in the Barkly Region

Scientific Name	Common Name	Declaration
<i>Cenchrus setaceum</i>	Fountain grass	Class B and C
<i>Parthenium hysterophorus</i>	Parthenium	Class A and C, WONS
<i>Cryptostegia grandiflora</i>	Rubber vine	Class A and C, WONS



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**LEGEND**

● Proposed Wells 2019	— Highway	● Athel pine	● Mesquite
■ Homestead	— Minor Road	● Belyache bush	● Neem
● Place Name	— Tracks	● Burr - Noogoora	● Parkinsonia
■ Populated Place	— Cadastre	● Gamba grass	● Prickly acacia
— Major Stream	▭ Permit Areas	● Grader grass	● Sida - Flannel weed
— Minor Stream	▨ Bullwaddy Conservation Reserve	● Hyptis	● Sida - Spiny head
— Access Tracks	⊕ Gravel Pits		■ Gamba Grass
			▲ Rubberbush

**LOCATION**

**ORIGIN ENERGY RESOURCES LIMITED**  
**2019 Environmental Management Plan**

**Weeds of the Permit Area**

PROJECT ID	60480548
CREATED BY	jace.ernberg
LAST MODIFIED	20-May-2019
VERSION	1

**Figure 7**

Data sources:  
Permit Area, Cadastre - NT Gov 2019  
Places, Vegetation - Aust Gov 2019  
Highways, Roads, Drainage - StreetPro 2019



### 3.5.4 Fauna and Habitat

Previous surveys and database searches indicate that the permit areas are an important area for a diverse array of fauna. The NT Fauna database provides records for the following fauna species (excluding migratory birds): 32 species of mammal, 198 species of birds, 96 species of reptiles and 19 species of frogs. Surveys undertaken elsewhere within the region have recorded:

- 78 bird, 33 reptile, 11 mammal and six frog species in the Bullwaddy Conservation Reserve (PWCNT, 2005)
- 148 bird, 47 reptile, 21 mammal and six frog species in the Junction Stock Reserve and nearby Newcastle Waters (Fleming *et al.*, 1983)
- 157 bird species within the project area as determined by a search of the Birds Australia bird atlas database (Birds Australia, 2010).

The proposed exploration sites are all located within similar habitat types consisting primarily of open *Eucalyptus/Corymbia* woodland with a tussock grass understorey. There are Bullwaddy/Lancewood communities around the proposed sites and individuals of both species are dispersed throughout. In the wider landscape, including proposed access tracks, additional vegetation types include those associated with drainage lines, grasslands/floodplains and acacia shrublands.

Eucalypt/Corymbia woodland provides habitat for a range of species. The proposed sites had high native grass cover and included numerous species suitable for granivorous birds (seed eaters). Dense leaf litter and numerous logs provide suitable refuge and foraging sites for fauna such as reptiles. Although most of the species found in this vegetation type are widespread in the tropical savannas of the Northern Territory, some such as the threatened Crested Shrike-tit (*Falcunculus frontatus whitei*) are rare and known to utilise this habitat (DoTEE, 2014, Ward, 2008). Many of the sites have a high density of hollow-bearing trees that provide important habitat for many fauna species. Avoiding clearing large hollow-bearing trees will reduce the impact to native wildlife within the permit area.

Savanna grasslands and open woodland provide suitable habitat for species such as Emu (*Dromaius novaehollandiae*) and Australian Bush Turkey (*Ardeotis australis*). Drainage lines and seasonally inundated grasslands may also provide habitat for migratory species during the wet season and are breeding areas for frogs. Limiting disturbances in these areas and avoiding these areas during the wet season would limit impacts on fauna.

#### 3.5.4.1 Threatened Fauna

A search of the DotEE Protected Matters database of nationally significant fauna (PMST), the NT Government fauna database (NRM Infonet), and records from the Atlas of Living Australia (ALA) was undertaken for the proposed lease areas and access tracks. The search results indicate the potential presence of 15 fauna species listed as threatened under the EPBC Act and/or the TPWC Act (Table 9). These included ten birds, eight mammals and two reptiles.

The likelihood assessment of species occurrence is based on the availability of suitable habitat within the permit area, records in the vicinity and distributional data. Therefore many of the threatened and migratory fauna species indicated in databases as 'occurring' or 'likely to occur' have been assessed as *unlikely to occur* within the proposed exploration lease areas. As some areas in the proposed lease area have not been subject to intensive survey and some species are very cryptic, a conservative approach has been taken to assess species presence. A full description of each species, their distribution and habitat associations are outlined in Table 9 below.

No core habitat for threatened fauna was identified at the sites. However, some species may possibly occur and are known to occur in the wider landscape. Threatened species that may possibly occur include:

- Gouldian Finch *Erythrura gouldiae* (E-EPBC Act, VU-TPWC Act)
- Crested Shrike-tit (northern) *Falcunculus frontatus whitei* (VU-EPBC Act, NT-TPWC Act)

Research has shown that critical components of suitable habitat for the Gouldian Finch include suitable nesting trees during the breeding season (particularly *E. tintinnans*, *E. brevifolia* or *E. leucophloia*), a water source and a diverse range of favoured annual and perennial grasses (DoE,

2015). No nesting habitat was recorded during the surveys and it is unlikely this species breeds in close vicinity of the sites. During the wet season Gouldian Finches move from breeding habitat on hillsides with suitable trees down to lower lying areas where they forage on perennial grasses such as *Triodia* sp., *Alloteropsis semialata*, and *Chrysopogon fallax* (Palmer *et al.* 2012). Some of the perennial grasses were recorded during recent surveys so potential foraging habitat is present; however, there are limited records in the vicinity of the sites suggesting it is not an important area for this species.

The Crested Shrike-tit lives in dry Eucalypt forests and woodland where it feeds on insects from the canopy and also under bark (Ward, 2008). It has been recorded in wet Melaleuca open woodlands, woodlands dominated by Nutwood (*Terminalia arastrata*), Bloodwoods with flaky bark and ironwood (DoE, 2014, Ward, 2008). In the NT, nesting has been recorded from September through to January and nests are built in terminal branches at the top of trees (Ward *et al.*, 2009). The stronghold of this species is north of this location and only one old record exists near Borroloola. Although it is possible this species may be present in the area, it is unlikely to represent an important area for this species and the impact of the proposed activities, given their size, would be small.

The Grey Falcon (*Falco hypoleucus*) is a widespread species listed as Vulnerable in the NT that is considered possibly to be present in the study area. The Painted Honeyeater (*Grantiella picta*) has been known to occur in the study area, however, given it does not breed in the NT it would only be present intermittently for foraging. Based on the field assessment there was no breeding habitat recorded, and depending on grass seed and water availability it is unlikely the study area comprises core habitat for this species.

As records of species may be limited in remote areas the precautionary principle has been applied. There are some species that have been assessed as possibly occurring even though their primary habitat is not found within the proposed sites or access tracks. These include species that are associated with ephemeral wetlands, low lying areas that may be seasonally inundated and creeks. During the wet and early dry season these areas may sustain threatened species such as wetland birds (including migratory species) and also the Plains Death Adder (*Acanthopis hawkei*).

Table 9 EPBC and TPWC Listed Threatened Species and Likelihood of Occurrence

Species	Conservation Status		Distribution	Habitat	Likelihood of Occurrence
	EPBC	NT			
<b>Birds</b>					
<i>Calidris ferruginea</i> Curlew Sandpiper	Marine Migratory	VU	In the NT this species occurs around Darwin, north to Melville Island and Cobourg Peninsula, and east and south-east to Gove. It has been recorded inland from Victoria River Downs and around Alice Springs (Higgins & Davies 1996).	Coastal habitats, inland it has been found around lakes, dams and ephemeral/permanent waterholes.	Unlikely (suitable habitat not present at survey sites but potential sporadic in wider landscape)
<i>Erythrotriorchis radiatus</i> Red Goshawk	VU	-	Found across most of Northern Australia, in the NT most records are from the Top End but there are records from central Australia (Pizzey & Knight, 2012).	Red Goshawks occupy a range of habitats, often at ecotones, including coastal and sub-coastal tall open forest, tropical savannahs crossed by wooded or forested watercourses. In the NT, it inhabits tall open forest/woodland as well as tall riparian woodland (Aumann & Baker-Gabb, 1991).	Unlikely (no records and core habitat absent)
<i>Erythrura gouldiae</i> Gouldian Finch	E	VU	Formerly widespread across northern Australia. In the NT they are found in the Top End south past Daly Waters (Palmer <i>et al.</i> , 2012).	Gouldian Finches occupy different habitat types in the breeding and non-breeding season. Breeding habitat consist of hillsides with suitable nesting trees. In the non-breeding season they are found in lowland drainages to feed on suitable perennial grasses (Dostine & Franklin, 2002).	Possible (sporadic, foraging only, no recent records)
<i>Falcunculus frontatus whitei</i> Crested Shrike-tit (northern)	VU	NT	This species has a very patchy distribution with records from the Victoria River District to Maningrida. Only one record near Borroloola (1930) (Woinarski & Ward, 2012).	Occupies wet and semi-arid melaleuca and eucalypt open woodlands. May be associated with bloodwoods with flaky bark and ironwood (Ward, 2008).	Possible (no records in vicinity although suitable habitat present, very rare)

Species	Conservation Status		Distribution	Habitat	Likelihood of Occurrence
	EPBC	NT			
<i>Falco hypoleucos</i> Grey Falcon	-	VU	This species has a widespread distribution and records for this species exist throughout the NT. However, most records are from arid and semi-arid regions (Pizzey and Knight, 2012).	Grey Falcons inhabit lightly treed inland plains, gibber desserts, sandridges, pastoral lands, timbered watercourses and, occasionally, the driest deserts. (Pizzey and Knight, 2012). Also found also in association with inland drainage systems.	Likely (probably not at proposed lease areas but likely in floodplains across the permit area)
<i>Geophaps smithii</i> Partridge Pigeon	VU	VU	Occurs across the Top End of the NT, declined/disappeared from lower rainfall areas (Woinarski, 2007).	Found predominantly in open eucalypt forest and woodland with grassy understories (Woinarski, 2007).	Unlikely (no records, occurs north of the permit area although some habitat present)
<i>Grantiella picta</i> Painted Honey Eater	VU	VU	This species is found throughout eastern Australia but breeding is known from south-eastern Australia (Pizzey and Knight, 2012). This species is rare.	This species specialises on the fruit of mistletoes although it may also forage on nectar and insects (Garnett <i>et al.</i> , 2011). Numerous large tracts of <i>Acacia shirleyi</i> with abundant mistletoes were recorded in the vicinity of the Beetaloo sites.	Possible (records from Barkly Tablelands but none in close vicinity, habitat present, foraging only)
<i>Polytelis alexandrae</i> Princess Parrot	VU	VU	Occupies arid lands in Australia where it is patchily distributed (Woinarski, 2007).	Found in sand dune habitat, spinifex with eucalypts, and shrubs such as acacias, hakeas, and eremophilas (Pizzey and Knight, 2012; Woinarski, 2007).	Unlikely (most records from southern arid region, not primary habitat)
<i>Rostratula australias</i> Australian Painted Snipe	CE	VU	In the NT, probably occurs in central and southern area although it also possible occurs in the northern portion of the area (Woinarski <i>et al</i> , 2007).	These birds prefer a habitat of recently flooded temporary vegetated wetlands during the non-breeding period and brackish temporary freshwater wetlands with minimum vegetation during breeding periods. Birds usually forage in thick, low vegetated areas during the day (Curtis <i>et al</i> , 2012).	Unlikely* (one record, no suitable habitat at drill sites but may be present in the wider landscape during the wet season)
<i>Tyto novvaehollandiae kimberli</i>	VU	VU	Distributed in Northern Australia although not well	This species inhabits tall open eucalypt forest in the NT, especially those associated	Unlikely

Species	Conservation Status		Distribution	Habitat	Likelihood of Occurrence
	EPBC	NT			
Masked Owl (northern)			known. In the NT, occurs from Cobourg south to Katherine and the VRD and east to the McArthur River (DOTE, 2014)	with <i>E. Miniata</i> and <i>E. tetradonta</i> (Woinarski, 2007). Also found in riparian and monsoonal forest and rainforest (DOTE, 2014)	(primary habitat absent)
<b>Mammals</b>					
<i>Dasyurus hallucatus</i> Northern Quoll	E	CE	Found throughout most of Northern Australia although now restricted to six main areas (Menkhorst & Knight, 2011). In the NT it is found in the Top End as far southeast as Boroloola (DOTE, 2014). One previous record from Shenandoah Pastoral Lease (unknown date).	Northern Quolls do not have highly specific habitat requirements although the most suitable appear to be rocky habitats (Woinarski, 2007). They occur in a variety of habitats across their range, including open forest and woodland. Daytime den sites provide important shelter. Shelter sites include rocky outcrops, tree hollows, hollow logs, termite mounds, goanna burrows and human dwellings.	Unlikely (no recent records, no core habitat)
<i>Pseudantechinus mimulus</i> Carpentarian Antechinus	–	VU	Found in QLD and the NT. In the NT it has been reported from the Sir Edward Pellew Island group, and Pungalina reserve near Boroloola.	This species is distributed in rocky habitat including sandstone boulders and outcrops with hummock grasses (Woinarski, 2004). In QLD, this species has been recorded on rocky ridges and hill-slopes (Lloyd <i>et al.</i> , 2013).	Unlikely (one record but no suitable habitat)
<i>Isodon auratus</i> Golden Bandicoot	V	E	This species used to be found across northern, central and western Australia but decline after European settlement (Woinarski, 2007). Now only found on Marchinbar Island in the NT and small area of the NW Kimberley (Fisher and Woinarski, 1994; Woinarski, 2007).	Previously inhabiting a range of arid and semi-arid habitats, in the NT it occupies heathland and shrubland and hummock grasslands on sandstone, vine thickets and grassy woodlands (Menkhorst and Knight, 2011; Woinarski, 2007).	Highly unlikely (only persists in NE Arnhemland)

Species	Conservation Status		Distribution	Habitat	Likelihood of Occurrence
	EPBC	NT			
<i>Macroderma gigas</i> Ghost Bat	VU	NT	The species' current range in northern Australia ranges from relatively arid conditions in the Pilbara region of Western Australia to humid rainforests of northern Queensland. A large colony occurs in a series of gold mine workings at Pine Creek, NT. This species have also been recorded throughout the mainland Top End north of approximately 17° latitude.	The distribution of this species is influenced by the availability of suitable caves and mines for roost sites (NTG, 2018).	Unlikely (no recent records, no suitable cave located near proposed sites)
<i>Macrotis lagotis</i> Greater Bilby	VU	VU	This species occurs in south-western Queensland and in arid north-western Australia (Western Australia and Northern Territory). This species was previously widespread in arid and semi-arid Australia (Pavey, 2009). The most northern records are from Newcastle Waters and Wave Hill (Southgate & Paltridge, 1998).	In the NT, this species is found on sandy soils dominated by spinifex (Pavey, 2009). Low shrubs such as <i>Acacias</i> and <i>Melaleucas</i> are also common in this habitat. Also hummock grassland associated with low lying drainage systems and alluvial areas.	Unlikely (no recent records, primary habitat limited in permit area)
<i>Saccolaimus saccolaimus nudicluniatus</i> Bare-rumped Sheath-Tailed Bat	CE	DD	Wide distribution from India through south-eastern Asia to the Solomon Islands, including north-eastern Queensland and the NT. The north-eastern Australian populations are described as the subspecies <i>S. s. nudicluniatus</i> , although it is	Previous specimens have been collected from Open <i>Pandanus</i> woodland fringing the sedgelands of the South Alligator River in Kakadu National Park (Friend and Braithwaite, 1986). In the NT, it has also been recorded from eucalypt tall open forests (Churchill, 1998)	Unlikely (no records and primary habitat not present)

Species	Conservation Status		Distribution	Habitat	Likelihood of Occurrence
	EPBC	NT			
			not clear whether this should be applied to the NT population (Duncan et al. 1999). There have been very few (<5 confirmed) records since (McKean et al. 1981; Thomson 1991). All confirmed records have been from the Kakadu lowlands.		
<i>Trichosurus vulpecula vulpecula</i> Common Brushtail Possum	–	E	Previously widespread in the NT, this species is now found in isolated locations in the southern NT (Woinarski, 2007).	This species occupies riparian habitat in the vicinity of rocky outcrops or slopes (Kerle <i>et al.</i> , 1992).	Unlikely (no records in the vicinity of the lease area and no suitable habitat)
<i>Rattus tunneyi</i> Pale Field-rat	–	V	Inhabiting higher rainfall area including the Top End of the NT (Menkhorst and Knight, 2011).	This species favours dense vegetation found along rivers where it occupies burrows in loose colonies (Cole and Woinarski, 2002). However, this species can be found in a variety of habitats including woodlands if a dense understorey of grasses is present (Menkhorst and Knight, 2011)	Unlikely (one record from 1999 in greater area, primary habitat absent)
<b>Reptiles</b>					
<i>Acanthopis hawkei</i> Plains Death Adder	VU	VU	In the NT this species is found in the floodplains of the Adelaide, Mary and Alligator Rivers and the Barkly Tablelands.	Found on flat cracking soils in treeless floodplains where it forages on frogs, reptiles and rats.	Unlikely (no records or suitable habitat)
<i>Varanus Mertensi</i> Mertens Water Monitor	–	V	Distributed throughout coastal and inland waters in northern Australia. In the NT found throughout most of the Top	Semi-aquatic species that inhabits vegetation associated with water such as Pandanus and paperbark. Seldom found far away from water (Mayes, 2006).	Unlikely* ( <u>was confirmed</u> during previous surveys along Newcastle

Species	Conservation Status		Distribution	Habitat	Likelihood of Occurrence
	EPBC	NT			
			End. Decrease in NT population attributed to Cane Toads.		Creek_habitat unsuitable at proposed exploration lease sites)



### 3.5.5 Feral Animals

Feral animals known to occur within the region include:

- Pig (*Sus scrofa*)
- Wild Dog (*Canis lupus familiaris*)
- Feral Cat (*Felis catus*)
- Cane Toad (*Bufo marinus*)
- Horse (*Equus caballus*)
- Donkey (*Equus asinus*)
- Water Buffalo (*Bubalus bubalis*)
- Camel (*Camelus dromedarius*)
- Black Rat (*Rattus rattus*)
- Domestic Cattle (*Bos Taurus*)

During the August 2018 survey evidence of cattle grazing in present or 1-2 years previously was recorded and in previous surveys of the permit area cat tracks were observed as the only non-native species recorded but based on records many species, especially Dogs/Dingo, Pigs and Cane Toads will be present in permit area. The disturbance from cattle within the proposed sites were considered to have resulted in less than 5% damage or no damage at all.

The Cane Toad is known to be present in the permit area and the Commonwealth DoTEE recognises this species as a 'key threatening process' related to their impacts on biodiversity through predation, competition, land degradation and poisoning. In the Northern Territory, the Cane Toad has been implicated in the decline of several species including a large number of reptiles such as the King Brown Snake and water monitors (Smith & Phillips, 2006).

Pest predators such as the Cat are most likely common although their abundance is difficult to assess due to their cryptic nature. Introduced predators such as Cats can impact many vertebrates (e.g. Dickman, 2009 & 1996). One of the primary concerns of introduced predators in the site is the impact on EPBC listed species such as reptiles, and ground-dwelling birds. Feral cats are believed to be one of factors that have led to the decline of threatened ground-dwelling bird the Partridge Pigeon (Woinarski *et al.* 2007)

Species could be attracted to the increased activities at the site potentially increasing their abundance in the landscape, and their control should be taken into consideration during the proposed activities on site. It is of key importance during all phases of the project that care is taken to ensure that rubbish is securely contained (i.e. with suitable lids) and removed from the site as soon as possible to discourage attracting any feral animals.

### 3.5.6 Fire

Fire is a natural occurrence in most Australian ecosystems and plays an important role in their ecology. Fire is generally excluded from Mitchell grasslands by pastoral management in order to maintain forage throughout the dry season (HLA, 2005) whereas fire is more frequent in the Sturt Plateau.

Historically, the majority of dry season fires (June to September) have occurred in the northern half of the permit area, in EP76, EP98 and EP117. At this time of year, the fires are likely to be high intensity (HLA, 2005). Wet season fires (October to May) have occurred within the permit area. These fires are likely to be patchy and of lower intensity, depending on the state of curing of the fuel load.

Bullwaddy and Lancewood communities, which are located throughout the permit area, are fire sensitive and hot fires have the ability to reduce habitat quality for both flora and fauna species. Research suggests that fauna diversity may be impacted by a hot fire, particularly for diurnal reptiles (e.g. Legge *et al.*, 2008).

Based on field data, fire disturbance was determined as follows:

- Vekerri 76 S2-1 – Fire Frequency 2-3 years previous, Intensity 1 (minor scars on some trees/shrubs and Height <1m).
- Kyalla 117 N2-1 – Fire Frequency 1-2 years previous, Intensity 4 (some trees and shrubs killed) and Height 1-4 m. It was noted that site appeared to have had a hot fire go through previously with abundance of new Acacia regrowth.

All sites that showed evidence of fire disturbance were showing signs of regrowth and recovery.

### **3.6 Land Condition Summary**

Detailed land condition description and photographs of each of the proposed lease areas (Velkerri 76 S2-1, Kyalla 117 N2-1) are provided in Table 10 and Table 11 below.

Table 10 Velkerri 76 S2 Condition Description







Site ID	Velkerri 76 S2	Habitat photos at central point of survey site (August 2018)	
<b>Location</b>	-16°51' 20.13, 134°23' 39.85		
<b>Landform and soil</b>	Plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products; sandy and earth soils. Trace of cracking clay soils.		
<b>Habitat type</b>	<i>Eucalyptus/Corymbia low woodland</i>		
<b>Vegetation Community</b>	Eucalyptus low woodland/low open tussock grassland This vegetation community is considered regionally extensive and not subjected to extensive clearing.		
<b>Dominant flora species</b>	Canopy dominated by <i>Corymbia dichromophloia</i> , <i>Erythrophleum chlorostachys</i> . Shrub layer including <i>Eucalyptus sp.</i> Ground layer species include <i>Aristida latifolia</i> , <i>Pterocaulon sphacelatum</i> , <i>Triodia bitextura</i> .		
<b>Habitat condition</b>	Good condition with evidence of recent grazing. Large hollow bearing trees and logs were common in the area. The large hollows provide suitable nesting and shelter for numerous fauna species including reptiles, arboreal mammals, and nocturnal birds. The habitat contained moderate refuge opportunities in the form of dense leaf litter, dense grass cover, and woody debris. Good continuous cover adjoining adjacent woodland habitat. No evidence of weeds or feral animals.	<b>Additional Habitat Photos across survey site (August 2018)</b>	
<b>Potential Listed Threatened Species</b>	Grey Falcon, Northern Shrike-tit, Plains Death Adder, Gouldian Finch.		

Table 11 Kyalla 117 N2-1 Condition Description

Site ID	Kyalla 117 N2-1	Habitat photos at central point of survey site (August 2018)	
Location	-16°50' 29.01, 133°39' 0.16		
Landform and soil	Plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products; sandy and earth soils		
Habitat type	<i>Corymbia</i> low woodland		
Vegetation Community	<i>Corymbia</i> low woodland/ <i>Terminalia</i> (mixed) sparse shrubland/ <i>Chrysopogon</i> (mixed) low tussock grassland This vegetation community is considered regionally extensive and not subjected to extensive clearing.		
Dominant flora species	Canopy dominated by <i>Corymbia dichromophloia</i> , <i>Eucalyptus setosa</i> . Shrub layer including <i>Acacia ancistrocarpa</i> , <i>Alphitonia pomaderroides</i> , <i>Brachychiton paradoxus</i> . Ground layer species include <i>Triodia bitextura</i>		
Habitat condition	Good condition with evidence of recent grazing. Vegetation appeared to heavily burnt in recent years. No evidence of hollow bearing trees and logs. The habitat contained moderate to high refuge opportunities in the form of dense leaf litter, tussock grass cover, and woody debris. Good continuous cover adjoining adjacent woodland habitat and regionally extensive. No evidence of weeds or feral animals.	<p style="text-align: center;"><b>Additional Habitat Photos across survey site (August 2018)</b></p>	
Potential Listed Threatened Species	Grey Falcon, Northern Shrike-tit, Plains Death Adder, Gouldian Finch.		

## 4.0 Conclusion

During August 2018, AECOM undertook a land condition assessment of the two proposed exploration lease areas and access tracks to provide a baseline assessment of ecological conditions in support of Origin Energy's application to the Northern Territory Department of Environment and Natural Resources, including the preparation of an Environmental Management Plan (EMP) for various exploration activities. Additional weed survey was conducted during June 2019 to further inform conditions at the site.

The purpose of the LCA was to gather baseline information to provide an environmental condition assessment to support the proposed exploration activities to be carried out by Origin at two proposed lease sites during 2019/2020.

The LCA identified the ecological conditions and documented the site condition prior to Origin commencement of exploration within two of their Permit Areas EP76 and EP117. The information obtained during the initial LCA will assist in determining that at the end of the exploration activities that the lease areas have been rehabilitated back to its natural state.

The proposed exploration program will have a total disturbance of approximately 24.5 ha and will utilise 107 km of existing access tracks.

The desktop review and field survey assisted in identifying the potential environmental risks and impacts to the environment based on the conditions identified on site and has allowed the development of mitigation measures to minimise Origin's impact on the environment.

During the survey of the proposed exploration lease areas, as well as the areas surrounding the proposed access tracks were assessed to be in generally good condition with no to low evidence of weeds, erosion and disturbance from cattle.

The likelihood assessment concluded that no EPBC listed threatened ecological communities or threatened species are likely to be significantly impacted from the proposed exploration program activities.

Overall, the impacts of the vegetation clearing for the proposed lease areas and access tracks are considered minor from a landscape perspective. Surrounding habitat is extensive and most species are mobile and will be able to access surrounding habitat.

The mitigation measures presented in the Drilling and Stimulation EMP would assist in minimising the impacts from Origin's activities on EPBC listed species and communities.

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# Appendix A

## Soil Test Results

Soil Id	Photo	Soil pH	Soil Colour	Dispersion Test Observations
Kyalla N2-1		5.14	1.5YR 4/6	<p><b>Initial Observation</b></p> <ul style="list-style-type: none"> <li>Sample was fully crumbed when submerged in demineralised water.</li> </ul> <p><b>Final Observation</b></p> <ul style="list-style-type: none"> <li>Non-dispersive, particles crumble though water remains clear.</li> </ul>
Velkerri S2		5.02	10YR 3/4	<p><b>Initial Observation</b></p> <ul style="list-style-type: none"> <li>Sample was fully crumbed when submerged in demineralised water.</li> </ul> <p><b>Final Observation</b></p> <ul style="list-style-type: none"> <li>Non-dispersive, particles crumble though water remains clear.</li> </ul>
<p><b>NOTE:</b>  Initial Observation - observation made when the sample was submerged in water  Final Observation - observation made after 2 hours</p>				

# Appendix B

Flora Species Record,  
August 2018

## Appendix B Flora Species Record, August 2018

Table 12 Flora Species Recorded, August 2018 Field Survey

Family	Genus	Species
Asteraceae	<i>Pterocaulon</i>	<i>sphacelatum</i>
Caesalpiaceae	<i>Erythrophleum</i>	<i>chlorostachys</i>
Combretaceae	<i>Terminalia</i>	<i>canescens</i>
		<i>arostrata</i>
	<i>Macropteranthes</i>	<i>kekwickii</i>
Euphorbiaceae	<i>Petalostigma</i>	<i>pubescens</i>
Fabaceae	<i>Acacia</i>	<i>ancistrocarpa</i>
		<i>shirleyi</i>
		<i>sp.</i>
Myrtaceae	<i>Corymbia</i>	<i>dichromophloia</i>
		<i>drysdalensis</i>
		<i>ferruginea</i>
Poaceae	<i>Aristida</i>	<i>holathera</i>
	<i>Chrysopogon</i>	<i>fallax</i>
	<i>Enneapogon</i>	<i>lindleyanus</i>
	<i>Eragrostis</i>	<i>spartinooides</i>
	<i>Eriachne</i>	<i>aristidea</i>
		<i>ciliata</i>
		<i>nervosa</i>
		<i>sp.</i>
	<i>Heteropogon</i>	<i>contortus</i>
	<i>Sarga</i>	<i>plumosum</i>
	<i>Schizachyrium</i>	<i>fragile</i>
	<i>Sporobolus</i>	<i>australasicus</i>
	<i>Themeda</i>	<i>triandra</i>
<i>Triodia</i>	<i>bitextura</i>	
	<i>sp.</i>	
Rhamnaceae	<i>Alphitonia</i>	<i>pomaderroides</i>
Sterculiaceae	<i>Brachychiton</i>	<i>paradoxum</i>

# Appendix C

## DotEE Protected Matters Search Report



# EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about [Environment Assessments](#) and the EPBC Act including significance guidelines, forms and application process details.

Report created: 27/08/18 10:22:23

[Summary](#)

[Details](#)

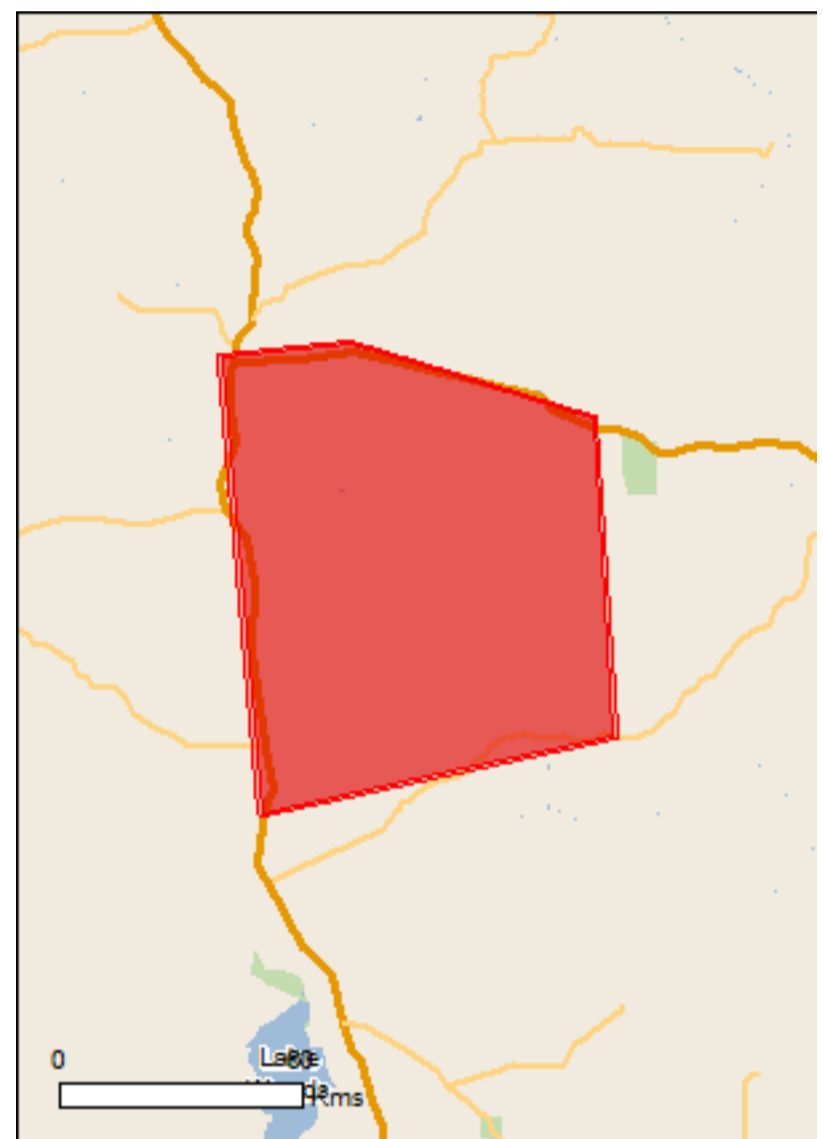
[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

[Acknowledgements](#)



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

[Coordinates](#)

[Buffer: 1.0Km](#)



# Summary

## Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the [Administrative Guidelines on Significance](#).

<a href="#">World Heritage Properties:</a>	None
<a href="#">National Heritage Places:</a>	None
<a href="#">Wetlands of International Importance:</a>	None
<a href="#">Great Barrier Reef Marine Park:</a>	None
<a href="#">Commonwealth Marine Area:</a>	None
<a href="#">Listed Threatened Ecological Communities:</a>	None
<a href="#">Listed Threatened Species:</a>	12
<a href="#">Listed Migratory Species:</a>	12

## Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at <http://www.environment.gov.au/heritage>

A [permit](#) may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

<a href="#">Commonwealth Land:</a>	None
<a href="#">Commonwealth Heritage Places:</a>	None
<a href="#">Listed Marine Species:</a>	19
<a href="#">Whales and Other Cetaceans:</a>	None
<a href="#">Critical Habitats:</a>	None
<a href="#">Commonwealth Reserves Terrestrial:</a>	None
<a href="#">Australian Marine Parks:</a>	None

## Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

<a href="#">State and Territory Reserves:</a>	1
<a href="#">Regional Forest Agreements:</a>	None
<a href="#">Invasive Species:</a>	15
<a href="#">Nationally Important Wetlands:</a>	None
<a href="#">Key Ecological Features (Marine)</a>	None



# Details

## Matters of National Environmental Significance

Listed Threatened Species		[ Resource Information ]
Name	Status	Type of Presence
<b>Birds</b>		
<a href="#">Calidris ferruginea</a> Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
<a href="#">Erythrotriorchis radiatus</a> Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Erythrura gouldiae</a> Gouldian Finch [413]	Endangered	Species or species habitat likely to occur within area
<a href="#">Falcunculus frontatus whitei</a> Crested Shrike-tit (northern), Northern Shrike-tit [26013]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Grantiella picta</a> Painted Honeyeater [470]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Rostratula australis</a> Australian Painted-snipe, Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
<a href="#">Tyto novaehollandiae kimberli</a> Masked Owl (northern) [26048]	Vulnerable	Species or species habitat may occur within area
<b>Mammals</b>		
<a href="#">Macroderma gigas</a> Ghost Bat [174]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Macrotis lagotis</a> Greater Bilby [282]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Saccolaimus saccolaimus nudicluniatus</a> Bare-rumped Sheath-tailed Bat, Bare-rumped Sheath-tail Bat [66889]	Vulnerable	Species or species habitat may occur within area
<b>Reptiles</b>		
<a href="#">Acanthophis hawkei</a> Plains Death Adder [83821]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Elseya lavarackorum</a> Gulf Snapping Turtle [67197]	Endangered	Species or species habitat may occur within area

Listed Migratory Species [\[ Resource Information \]](#)

\* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
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Migratory Marine Birds

[Apus pacificus](#)

Fork-tailed Swift [678]

Species or species habitat likely to occur within area

Migratory Terrestrial Species

[Cecropis daurica](#)

Red-rumped Swallow [80610]

Species or species habitat may occur within area

[Cuculus optatus](#)

Oriental Cuckoo, Horsfield's Cuckoo [86651]

Species or species habitat may occur within area

[Hirundo rustica](#)

Barn Swallow [662]

Species or species habitat may occur within area

[Motacilla cinerea](#)

Grey Wagtail [642]

Species or species habitat may occur within area

[Motacilla flava](#)

Yellow Wagtail [644]

Species or species habitat may occur within area

Migratory Wetlands Species

[Actitis hypoleucos](#)

Common Sandpiper [59309]

Species or species habitat known to occur within area

[Calidris acuminata](#)

Sharp-tailed Sandpiper [874]

Species or species habitat may occur within area

[Calidris ferruginea](#)

Curlew Sandpiper [856]

Critically Endangered

Species or species habitat may occur within area

[Calidris melanotos](#)

Pectoral Sandpiper [858]

Species or species habitat may occur within area

[Charadrius veredus](#)

Oriental Plover, Oriental Dotterel [882]

Species or species habitat may occur within area

[Glareola maldivarum](#)

Oriental Pratincole [840]

Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [\[ Resource Information \]](#)

\* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
------	------------	------------------

Birds

[Actitis hypoleucos](#)

Common Sandpiper [59309]

Species or species habitat known to occur within area

[Anseranas semipalmata](#)

Magpie Goose [978]

Species or species habitat may occur within

Name	Threatened	Type of Presence area
<a href="#">Apus pacificus</a> Fork-tailed Swift [678]		Species or species habitat likely to occur within area
<a href="#">Ardea alba</a> Great Egret, White Egret [59541]		Species or species habitat known to occur within area
<a href="#">Ardea ibis</a> Cattle Egret [59542]		Species or species habitat may occur within area
<a href="#">Calidris acuminata</a> Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
<a href="#">Calidris ferruginea</a> Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
<a href="#">Calidris melanotos</a> Pectoral Sandpiper [858]		Species or species habitat may occur within area
<a href="#">Charadrius veredus</a> Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
<a href="#">Chrysococcyx osculans</a> Black-eared Cuckoo [705]		Species or species habitat known to occur within area
<a href="#">Glareola maldivarum</a> Oriental Pratincole [840]		Species or species habitat may occur within area
<a href="#">Haliaeetus leucogaster</a> White-bellied Sea-Eagle [943]		Species or species habitat may occur within area
<a href="#">Hirundo daurica</a> Red-rumped Swallow [59480]		Species or species habitat may occur within area
<a href="#">Hirundo rustica</a> Barn Swallow [662]		Species or species habitat may occur within area
<a href="#">Merops ornatus</a> Rainbow Bee-eater [670]		Species or species habitat may occur within area
<a href="#">Motacilla cinerea</a> Grey Wagtail [642]		Species or species habitat may occur within area
<a href="#">Motacilla flava</a> Yellow Wagtail [644]		Species or species habitat may occur within area
<a href="#">Rostratula benghalensis (sensu lato)</a> Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area
<b>Reptiles</b>		
<a href="#">Crocodylus johnstoni</a> Freshwater Crocodile, Johnston's Crocodile, Johnston's River Crocodile [1773]		Species or species habitat may occur within area

## Extra Information

### State and Territory Reserves [\[ Resource Information \]](#)

Name	State
Frew Ponds	NT

### Invasive Species [\[ Resource Information \]](#)

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resources Audit, 2001.

Name	Status	Type of Presence
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#### Frogs

Rhinella marina Cane Toad [83218]		Species or species habitat may occur within area
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#### Mammals

Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
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Bubalus bubalis Water Buffalo, Swamp Buffalo [1]		Species or species habitat likely to occur within area
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Camelus dromedarius Dromedary, Camel [7]		Species or species habitat likely to occur within area
---	--	--

Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
--	--	--

Equus caballus Horse [5]		Species or species habitat likely to occur within area
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Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
--	--	--

Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
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Sus scrofa Pig [6]		Species or species habitat likely to occur within area
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#### Plants

Name	Status	Type of Presence
Acacia nilotica subsp. indica Prickly Acacia [6196]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area
Jatropha gossypifolia Cotton-leaved Physic-Nut, Bellyache Bush, Cotton-leaf Physic Nut, Cotton-leaf Jatropha, Black Physic Nut [7507]		Species or species habitat likely to occur within area
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Vachellia nilotica Prickly Acacia, Blackthorn, Prickly Mimosa, Black Piquant, Babul [84351]		Species or species habitat likely to occur within area

## Reptiles

Hemidactylus frenatus Asian House Gecko [1708]		Species or species habitat likely to occur within area
---	--	--

# Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

# Coordinates

-16.305477 133.356741,-16.297568 133.356741,-16.269886 133.641013,-16.428018 134.180716,-17.098628 134.226035,-17.263941 133.447379,-16.305477 133.356741

# Acknowledgements

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- [-Office of Environment and Heritage, New South Wales](#)
- [-Department of Environment and Primary Industries, Victoria](#)
- [-Department of Primary Industries, Parks, Water and Environment, Tasmania](#)
- [-Department of Environment, Water and Natural Resources, South Australia](#)
- [-Department of Land and Resource Management, Northern Territory](#)
- [-Department of Environmental and Heritage Protection, Queensland](#)
- [-Department of Parks and Wildlife, Western Australia](#)
- [-Environment and Planning Directorate, ACT](#)
- [-Birdlife Australia](#)
- [-Australian Bird and Bat Banding Scheme](#)
- [-Australian National Wildlife Collection](#)
- [-Natural history museums of Australia](#)
- [-Museum Victoria](#)
- [-Australian Museum](#)
- [-South Australian Museum](#)
- [-Queensland Museum](#)
- [-Online Zoological Collections of Australian Museums](#)
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- [-Royal Botanic Gardens and National Herbarium of Victoria](#)
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- [-Australian National Herbarium, Canberra](#)
- [-University of New England](#)
- [-Ocean Biogeographic Information System](#)
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- [-CSIRO](#)
- [-Australian Tropical Herbarium, Cairns](#)
- [-eBird Australia](#)
- [-Australian Government – Australian Antarctic Data Centre](#)
- [-Museum and Art Gallery of the Northern Territory](#)
- [-Australian Government National Environmental Science Program](#)
- [-Australian Institute of Marine Science](#)
- [-Reef Life Survey Australia](#)
- [-American Museum of Natural History](#)
- [-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania](#)
- [-Tasmanian Museum and Art Gallery, Hobart, Tasmania](#)
- [-Other groups and individuals](#)

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the [Contact Us](#) page.