

Date : 17/05/2019 11:35:11 AM

From : "MCCOSKER Juliana"

To : " s.73**"**

Subject : Accepted: Groundwater Workshop

Published on DES Disclosure Log
RTI Act 2009

Date : 27/05/2019 9:28:41 AM

From : "BENNINK Kate"

To : "MCCOSKER Juliana"

Subject : Advice request and costing response_CSIRO_GA_24May2019_for_submission

Attachment : Advice request and costing response_CSIRO_GA_24May2019_for_submission.docx;

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Advice request | Queensland Department of Environment and Science (QDES) request on Carmichael Coal Mine Project Groundwater Dependent Ecosystem Management Plan (GDEMP)

This proposal responds to a request for advice from the Queensland Department of Environment and Science on 20 May 2019 with regard to the Carmichael Coal Mine Project. This proposal sets out the advice sought, our understanding of the request, provides a costing estimate, delivery timeframe, and personnel roles and responsibilities.

Review documents (for clarification please note DES does not require a review of the GMMP): GDEMP v11b (track change versions v10 – v11 and v11a-11b attached);

1 Advice regarding the source aquifer(s) of the Doongmabulla Springs Complex (DSC)

The following are excerpts from the request letter sent to Geoscience Australia (GA) and the CSIRO.

Following the department's review of the CSIRO/GA 2019 Report, the department seeks your advice about the type of investigation and research that may provide greater certainty regarding the department's interest in relation to the identification of the source aquifer(s) to the Doongmabulla Springs Complex (DSC).

The environmental authority (EA) for the Carmichael Coal Mine requires Adani to develop and implement a Groundwater Dependent Ecosystems Management Plan (GDEMP). The term GDEMP is defined in the EA and states, among other things, that a GDEMP must include 'detailed baseline research to establish the source aquifer(s) for groundwater supply to each groundwater dependent ecosystem [potentially or indirectly impacted by mining activities].

Having regard for **the 2019 Report, the 2018 advice, and the meeting on 16 April 2019**, the department asks three questions to clarify their understanding about further research (steps) to improve the certainty about the source aquifer(s) of the DSC and other groundwater dependent ecosystems.

- 1. Does the above summary accurately reflect the CSIRO/GA advice with respect to further work that could increase certainty of the source aquifer(s) for the DSC?*
- 2. Would CSIRO/GA recommend any additional measures?*
- 3. Would it be appropriate from an adaptive management framework for all the above matters to be undertaken over a set period i.e. prior to the model review (re-run)?*

2. Advice regarding acceptable levels of uncertainty for groundwater research and modelling, groundwater drawdown trigger thresholds and adaptive management measures in the updated GDEMP.

Based on GDEMP 11b (track change version/s) and the CSIRO/GA advice dated November 2018 and February 2019, the department seeks your additional advice on the following questions:

- 4. Generally, in respect to groundwater research and modelling, is it acceptable and/or common from a scientific basis to have some level of uncertainty? i.e. can source aquifer(s) ever be categorically determined or definitively identified? Can you have absolute certainty? Is there always some level of uncertainty?*

5. *Are the groundwater drawdown trigger thresholds proposed in the updated GDEMP 11b appropriate and suitable to ensure the long-term protection of the DSC in light of your advice that the numerical model is not fit for purpose?*
6. *For question 5, are the adaptive management measures and commitments in the updated GDEMP appropriate? If not, please provide suggestions to address this?*

Scope of advice to be provided by GA-CSIRO

The joint response from GA and CSIRO will:

- Build upon existing advice to DoEE but incorporate changes to recent documents, specifically changes in GDEMPv11b
- Rely on documents supplied by QDES, in particular the 'tracked changes' versions of the GDEMP that contain all changes made between document versions 'v10 to v11' and 'v11a to v11b'
- Seek a single point of contact in QDES for CSIRO and GA staff to clarify technical matters

Cost estimates

GA Cost: \$24,907 includes technical assessment, peer review and agency clearance.

CSIRO Cost – \$23,503 includes technical assessment, peer review and agency clearance.

Estimated total cost: \$48,410 GST exclusive

Delivery of services

From date of contract execution the advice would be delivered to QDES by no later than **COB Friday 7 June 2019** in the form of a short report. This timeline assumes the scope of work remains unchanged from that set out above.

Resourcing

GA Staff and effort

Role	Days
GA Response coordinator	2
Hydrodynamics – Senior	2
Hydrochemistry – Senior	5
Geology/Hydrogeology - Senior	5

GA Cost – \$24,907 includes technical assessment, peer review and agency clearance.

CSIRO Staff and effort

Role	Days
CSIRO coordinator and reviewer	2
GDE Ecologist	5
Groundwater hydrologist	5

CSIRO Cost – \$23,503 includes technical assessment, peer review and agency clearance.

Role descriptions

GA and CSIRO Response coordinator 1) technical hydrogeological lead to direct response 2) uphold scientific impartiality and integrity, 3) coordinate a cohesive response across agencies and disciplines, and 4) support and facilitate response through cross-disciplinary collaboration

GA Geology/Hydrogeology - Senior 1) consider the strategic implications of proponent's preferred hydrogeological (including structure) conceptualisation and plausible/reasonable alternatives, 2) Provide strategic technical advice under broad direction, 3) evaluate and communicate risks, in the technical context.

GA Hydrodynamic - Senior 1) to assess and evaluate the adequacy and feasibility of proponent technical methodology and approaches including hydraulic parameterisation and water flow, 2) Provide high level specialist technical advice under broad direction, 3) Evaluate, prioritise and communicate identified technical risks in the context of a multi-disciplinary science advice response, and 4) contribute to a concise and timely cohesive advice response to support decision making.

GA Hydrochemistry - Senior 1) to assess and evaluate the adequacy and feasibility of proponent technical methodology and approaches including bulk chemistry and water quality, 2) Provide high level specialist technical advice under broad direction, 3) Evaluate, prioritise and communicate identified technical risks in the context of a multi-disciplinary science advice response, and 4) contribute to a concise and timely cohesive advice response to support decision making.

CSIRO Groundwater hydrologist 1) to assess and evaluate the adequacy and feasibility of proponent technical methodology and approaches including numerical methods, model parameterisation and conceptual implementation, 2) Provide high level specialist technical advice under broad direction, 3) Evaluate, prioritise and communicate identified technical risks in the context of a multi-disciplinary science advice response, and 4) contribute to a concise and timely cohesive advice response to support decision making.

CSIRO Ecologist 1) to assess and evaluate the adequacy and feasibility of proponent technical methodology and approaches including ecosystem monitoring and mitigation measures, 2) Provide high level specialist technical advice under broad direction, 3) Evaluate, prioritise and communicate identified technical risks in the context of a multi-disciplinary science advice response, and 4) contribute to a concise and timely cohesive advice response to support decision making.

Date : 31/05/2019 2:35:05 PM

From : "Emily Turner"

To : "BENNINK Kate"

Cc : "MCCOSKER Juliana"

Subject : Attendees at mtg 16/4 [SEC=OFFICIAL:Sensitive, ACCESS=PersonalPrivacy]

Attachment : image001.jpg;

Hi Kate,

Hope you're well!

I think attendees at the meeting on 16 April were:

s.78B(2)

Melissa Wells, Kate Bennink, Juliana McCosker, Sonia Claus

s.78B(2)

sch4p4(6) Personal information s.78B(2)

s.78B(2)

Assistant Director | Post Approvals Strategies

Environment Standards Division

Department of the Environment and Energy

T 02 6275 9726 | [E emily.turner@environment.gov.au](mailto:emily.turner@environment.gov.au)

The Department acknowledges the traditional owners of country throughout Australia and their continuing connection to land, sea and community. We pay our respects to them and their cultures and to their elders both past and present



Date : 17/05/2019 10:11:05 AM
From : "BENNINK Kate"
To : "MCCOSKER Juliana"
Subject : can you please review?
Attachment : DG Brief_CSIRO 17052019.docx;

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SECURITY CLASSIFICATION: UNCLASSIFIED

BRIEFING NOTE – DIRECTOR-GENERAL

Subject Engagement of CSIRO to provide advice relating to the Adani Carmichael Coal Mine Groundwater Dependent Ecosystem Management Plan

Approval required as soon as possible.

RECOMMENDATION

It is recommended that the Director-General:

- **approve** the engagement of CSIRO to provide advice relating to the Adani Carmichael Coal Mine Groundwater Dependent Ecosystem Management Plan (GDMP) (see terms and conditions in **Attachment 1**).

BACKGROUND

- On 9 April 2019, Adani submitted the most recent version of the GDMP (version 11b).
- The Commonwealth Department of the Environment and Energy (DOEE) previously engaged CSIRO and Geoscience to review the GDMP (version 10a), before the Federal Minister decided to approve that version of the GDMP on 9 April 2019.
- CSIRO and Geoscience Australia's review report (February 2019) was received by DES on 9 April 2019.
- DES met with DOEE, CSIRO and Geoscience Australia representatives on 16 April 2019 to discuss the review report.
- DES requires clarification on
- On 10 May 2019, DES wrote to CSIRO and Geoscience Australia requesting advice on five areas (see **Attachment 2**).
- CSIRO and Geoscience have agreed in principle to provide the advice on a fee for service basis.

KEY ISSUES

- CSIRO will subcontract to Geoscience Australia through a standing order arrangement, therefore DES only require a contract with CSIRO.
- See **Attachment 1** for draft contract terms and conditions.

ELECTION/CABINET/PUBLIC COMMITMENTS/LEGISLATION

- DES is required to make a decision whether to approve the GDMP under environmental authority (EA) condition XX for the Carmichael Coal Mine.
- DES has publically stated that advice on version 11b of the GDMP will be sought from CSIRO and Geoscience Australia.

FINANCIAL IMPACTS

- Funding is available from within existing divisional budget.
- The estimated cost for the advice is approximately \$xxx.

CONSULTATION

- Procurement Services (mandatory if approval is related to a procurement exercise).
- Principal Finance Officer, Environmental Services and Regulation.

FUTURE STEPS

- The delegate will assess the GDMP submitted by Adani on 9 April 2019 against the EA requirements.
- The delegate will consider the advice from CSIRO and Geoscience Australia when assessing the GDMP.

Endorsed

Noted / Approved / Not Approved

Rob Lawrence

Deputy Director-General

Environmental Services and Regulation

xx / 5 / 2019

Jamie Merrick (or Executive Director on behalf of)

Director-General

/ /

Director-General or Executive Director comments

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Date : 8/05/2019 5:17:41 PM
From : "CLAUS Sonia"
To : "MCCOSKER Juliana"
Subject : comments on report
Attachment : WRNB 2278 GDEMP.docx;image001.png;image002.png;
Hi Juliana

See attached draft comments on the second report. I have started putting detailed comments into the pdf. But am only half way. The main issue is still the consistency issues with the indicators between sections and tables. I have summarised these and provided examples based on the Carmichael River GDE.

I'll be working at home tomorrow and will be contactable after 10:30 if you have any questions.

Thanks
Sonia



Dr Sonia Claus
A/Principal Scientist
Environmental Monitoring and Assessment Science, Science Division
Department of Environment and Science

P 3170 5559
EcoSciences Precinct, Level 1 Block B, East Wing
41 Boggo Road, Dutton Park 4102
GPO Box 2454, Brisbane QLD 4001

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Date : 30/05/2019 3:59:25 PM

From : "WELLS Melissa"

To : "4(6) Personal information" <[redacted]@csiro.au>, "4(6) Personal information" <[redacted]@csiro.au>

Cc : "MCCOSKER Juliana", "s.78B(2)" <[redacted]@ga.gov.au>

Subject : DES technical contact

sch4(6) Personal information

Juliana McCosker (07) 4987 9356 is our technical contact. Happy to arrange Skype or teleconference if that assists with the review or just to provide any clarification.

Kind regards,
Melissa.

Sent from my iPhone

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Date : 21/05/2019 2:14:48 PM
From : "BENNINK Kate"
To : "WELLS Melissa"
Cc : "MCCOSKER Juliana"
Subject : dot points

Clarification:

- The request is solely in terms of the GDEMP and no review of the GMMP is requested.
- The Department will provide the track changes versions of the GDEMP to highlight any amendments between version 10a and version 11b, as the scope our request focuses on these amendments only.

Clarification – Question 1:

- DES understanding from the CSIRO/GA advice to DOEE is that the Clematis Sandstone is not the only source. We do not require CSIRO/GA to re-address this point.
- From the CSIRO/GA advice to DOEE there is agreement that the Clematis Sandstone is the principal/main source and therefore DES is asking about the level of confidence that CSIRO/GA have in this conclusion.

Clarification – Question 2:

- The CSIRO/GA advice refers to a level of uncertainty with regards to the source aquifer(s). Please provide commentary about your understanding of this uncertainty, the level of confidence you have in the conclusions you drew in the previous advice, and any quantification of the level of confidence and uncertainty.
- Question 2 only relates to whether DES has accurately captured the details of the additional work recommended on 16 April 2019 correctly in points 1 to 6 to increase the certainty of the source aquifer(s).
- With respect to Question 3 – please provide indicative and reasonable timeframes only (for example, is the information presently available? Or how long would it take to complete the analysis?).
- Question 4 re-framed – Are the groundwater drawdown trigger thresholds proposed in the new GDEMP appropriate and suitable to ensure the long-term protection of the DSC in light of your advice that the numerical model is not fit for purpose?

Date : 31/05/2019 1:17:01 PM

From : s.78B(2)

To : "MCCOSKER Juliana"

Subject : FW: DES technical contact [DLM=Sensitive]

Attachment : image001.png;image002.png;image003.png;image004.png;image005.png;

Hi Juliana,

Thank you for being the technical contact. We were unable to meet on the 16 of April as sh4p4(6) Personal information Given the current request to GA/CSIRO refers to the meeting, it is my understanding that QDES was to keep a record of the meeting minutes/notes. Would you be able to provide the meeting minutes/notes to allow me context to what was discussed?

Kind regards

s.78B(2)

| A/g Director

Groundwater Advice and Data | Environmental Geoscience Division

t +61 2 6249 9621 | www.ga.gov.au

GEOSCIENCE AUSTRALIA

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On 30/5/19, 4:18 pm, "MCCOSKER Juliana" <Juliana.Mccosker@des.qld.gov.au> wrote:

Hi s.78B(2)

Please see attached the latest copy of the GMMP submitted by Adani today. Does not include all the appendices.

Ciao for now

Juliana

-----Original Message-----

From: WELLS Melissa <Melissa.Wells@des.qld.gov.au>

Sent: Thursday, 30 May 2019 3:59 PM

sh4p4(6) Personal information sh4p4(6) Personal information sh4p4(6) Personal information

Cc: MCCOSKER Juliana; s.78B(2) @ga.gov.au

Subject: DES technical contact

sh4p4(6) Personal information

Juliana McCosker (07) 4987 9356 is our technical contact. Happy to arrange Skype or teleconference if that assists with the review or just to provide any clarification.

Kind regards,
Melissa.

Sent from my iPhone

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Date : 17/05/2019 4:34:46 PM

From : "BENNINK Kate"

To : "WELLS Melissa"

Cc : "MCCOSKER Juliana"

Subject : Fwd: Letter re new information re Adani GDEMP

Attachment : DES GDEMP Letter May 2019.pdf;ATT00001.htm;
FYI

Kate Bennink

Director | Business Centre Coal

Department of Environment and Science

P 4987 9338 | M sch4p4(6) Personal information

E kate.bennink@des.qld.gov.au

Begin forwarded message:

From: Carmel Flint <carmelflint@tpg.com.au>

Date: 17 May 2019 at 4:05:20 pm AEST

To: MERRICK Jamie <Jamie.Merrick@des.qld.gov.au>

Cc: BENNINK Kate <Kate.Bennink@des.qld.gov.au>

Subject: Letter re new information re Adani GDEMP

Hi Jamie,

Please find attached a letter from Lock the Gate Alliance about new information relating to the Adani GDEMP.

We would greatly appreciate an opportunity to meet to discuss these matters in more detail.

Could you advise whether you are available for a meeting and what might be a suitable time and date?

Thank you,

Carmel

Carmel Flint

Campaign Coordinator

Lock the Gate Alliance

sch4p4(6) Personal information

Jamie Merrick
Director-General
Department of Environment and Science
GPO Box 2454, Brisbane Queensland 4001
By email to Jamie.Merrick@des.qld.gov.au



15th May 2019

Dear Jamie,

Re New information re Adani Groundwater Dependent Ecosystem Management Plan (GDEMP)

I am writing in relation to Adani's GDEMP and the recent reports provided on it by CSIRO and Geoscience Australia (dated November 2018 and February 2019).

As you are aware, the Adani EA requires that the source aquifer for groundwater dependent ecosystems, including the Doongmabulla Springs, are definitively identified in the GDEMP.

In light of that, you have stated previously that Adani would have to find the source aquifer of the Doongmabulla Springs complex before the GDEMP is approved

Reports confirm source aquifer/s have NOT been identified

However, the two CSIRO/Geoscience Australia reports confirm categorically that the source aquifers of the Doongmabulla Springs have not been conclusively identified.

The February 2019 report states that:

"It is not plausible and reasonable to state unequivocally that the Clematis Sandstone is the sole source aquifer for the DSC, as sufficient uncertainty surrounding hydrogeochemistry, inter-aquifer connectivity and groundwater flow exists (Currell et al., 2017; Lewis et al., 2018; Webb et al., 2015) to necessitate a precautionary approach to the conceptualisation (as ruled by the Land Court of Queensland, 2015).

Documents provided by the Proponent, including the GMMP, support the conceptualisation that the Clematis Sandstone is a source aquifer, but there is enough uncertainty around the information provided, as acknowledged by the Proponent, such as in GDEMP Section 4.3.1, to necessitate a robust assessment of potential alternative or additional source aquifers. The paucity of water level and hydrochemistry data for units other than the Clematis Sandstone in the vicinity of the DSC means that it is not possible to conclusively determine the source aquifer or aquifers for the DSC based on available evidence, and thus the precautionary principle must apply".

The November 2018 report states that:

“Evidence provided in the GABSRP supports the conceptualisation that the Clematis Sandstone is a source aquifer, but there is enough uncertainty around the information provided, as acknowledged by the Proponent, to necessitate a robust assessment of potential alternative or additional source aquifers. In addition, and as summarised below, the body of existing evidence available in the public domain shows that there is ambiguity in the source aquifers of the Doongmabulla Springs Complex (Currell et al., 2017; Evans et al., 2018; Fensham et al., 2016; Land Court of Queensland, 2015; Lewis et al., 2018; Webb et al., 2015; Webb, 2015).....

*The information provided and available in the public domain indicates that it is both plausible and reasonable that units other than the Clematis Sandstone, including below the Rewan Formation may be a source aquifer for the DSC. If these other units are providing flow to the DSC, then this would lead to an increase in impacts to the springs (high consequence) and is considered plausible (medium likelihood) – **High risk**.....*

And..... “until such time as more data is provided in the research and management plans, the conceptualisation whereby the Clematis Sandstone is recognised as the sole source aquifer is not the only reasonable and plausible conclusion”.

Additional work required to identify the source aquifer/s

The two reports also provide a number of recommendations about additional research that is or should be required to better understand groundwater interactions and to identify the source aquifer of the springs. Extra research which they refer to includes:

- a. Appropriate geochemical characterisation for each potential contributor to spring flow.
- b. Nested or adjacent bores installed to measure pressure in multiple hydrostratigraphic units
- c. A high resolution ground surface elevation model to properly assess groundwater pressures.
- d. Accurate stream gauging data.
- e. A three dimensional geological model, including geological structures and lithofacies variation.
- f. Additional seismic data acquisition

Specifically, the February 2019 report recommends that:

“To constrain the source aquifer(s) of the DSC, a more sophisticated statistical analysis of hydrochemistry data is required. This includes assessing a wider variety of groundwater and surface water analytes, as well as appropriate use of isotope hydrochemistry analysis. Further information on potential techniques is provided in (CSIRO and Geoscience Australia, 2018) and other readily available references.”

The November 2018 report states that:

Nested or adjacent bores installed to measure pressure in multiple hydrostratigraphic units are required to adequately assess groundwater pressure as it relates to springs, and also to address data gaps identified in the broader hydrogeological conceptualisation.....

A high resolution ground surface elevation model is required to properly assess groundwater pressures in relation to groundwater interaction with the land surface and contributions to and from surface water bodies. Similarly, accurate stream gauging data is required. This also extends to a need for representative spring flow measurements.....

Appropriate geochemical characterisation for each potential contributor to spring flow is necessary to identify spring source aquifers. This includes aquifer materials, surface water and groundwater. This type of assessment should consider a broad suite of parameters including but not limited to anions, cations, trace metals, and isotopes with analytical detection limits at trace levels, including parameters that are commonly associated with coal. This analysis and assessment should involve chemical and isotopic measurements of aquifer formations and springs, as well as alluvium and surface water.....

....a three dimensional geological model, including geological structures and lithofacies variation would provide extremely valuable information to underpin any hydrogeological conceptualisation, including the characteristics of the Rewan Formation.

Additional seismic data acquisition may be warranted, given the data quality issues that may affect reprocessing historical data outlined above....”

In light of these very strong conclusions from our premier scientific bodies, we are writing to seek confirmation that Adani will be required to conduct all of the research identified in the CSIRO/Geoscience Australia reports prior to any further consideration of the GDEMP by DES.

We note that any approval of the GDEMP without conducting the research identified by these scientific reports is likely to fall foul of the legal requirements set down in the Adani EA.

We would appreciate a response as to whether Adani will be required to undertake the full suite of research identified by CSIRO and Geoscience Australia, as listed above. I can be contacted at any time on 0400 521474 or by email at carmelflint@tpg.com.au

Yours sincerely,

sch4p4(6) Personal information

Carmel Flint,
Campaign Coordinator, Lock the Gate Alliance
PO Box 55 Helensvale Qld

2/5/19

9DEMP/gmmp

1. Resource Squatter Report -> CSIRO/qa ?

Flight TOR for review

- what level of certainty.

Timeline - 10 days - as much as we
can give you.

CSIRO/qa - memo.

- clarification

- re certainty of source

- hydrogeology

- air born electro magnetic

- conceptual model

- sustainability issues

meeting 10/5/19 - 10.00 am.

9DEMP/gmmp

Resource squatter never completed
uncertainty

caution re. CSIRO/qa

- Deem will get back to Paul as when CSIRO/qa
word to guests

- talk to CSIRO/qa early next week. email
date

- when advice comes back

- Advise to the H.A.

Monday

20/5/19

- Monday

Wednesday

BT.FMP.

- BT.FMP

- 9MMP - Brisbane

Warrish to supply leadback

- Rocky

- in prep for lead 15th

10/5/19

Date : 8/05/2019 5:10:03 PM

From : "[REDACTED] s.73"

To : "WELLS Melissa"

Cc : "[REDACTED] s.73", "MCCOSKER Juliana"

Subject : Meeting on Friday 10th May 2019

Attachment : image001.jpg;

Dear Melissa,

I note that we are meeting with you this Friday 10th May to discuss a number of management plans for the Carmichael Coal project and the proper completion of that process.

With respect to that meeting:

- On the BTFMP, on a forward looking basis we are seeking to obtain clarity from you around matters raised in Attachment A provided to us on 2nd May 2019 and, if we were to do so, how those matters may be incorporated into any revised BTFMP. We are also seeking confirmation of process and timing with respect to the approval process for this plan.
- On the GDEMP, we are awaiting the Department's feedback on Version 9 of this plan, available on our website. We are also seeking confirmation of process and timing with respect to the approval process for this plan.
- On the GMMP, we are awaiting the Department's feedback on Version 7 of this plan as referred to in my email today and available on our website. We are also seeking confirmation of process and timing with respect to the approval process for this plan.

Lastly, can you please confirm the location details for the meeting.

Kind regards,

[REDACTED]
s.73

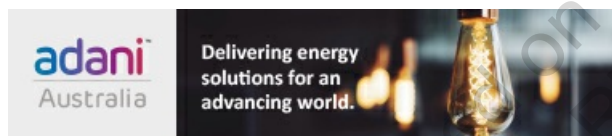
E [REDACTED] s.73 @adani.com.au

P office: +61 7 3223 4800 | direct: [REDACTED] s.73

A Level 25, 10 Eagle Street, Brisbane, QLD, 4000

P GPO Box 2569, Brisbane, QLD, 4001

W adaniaustralia.com



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Date : 8/05/2019 1:36:57 PM

From : "BENNINK Kate"

To : "CLAUS Sonia" , "MCCOSKER Juliana"

Subject : my review of letter

Attachment : Letter to CSIRO-GA clarification 090519 KB.docx;image001.png;

Hi Juliana and Sonia, I've made some edits in tracked changes and asked some questions for consideration. Cheers Kate



Kate Bennink

Director

Business Centre Coal | Coal and Central Queensland
Compliance

Environmental Services and Regulation

Department of Environment and Science

P (07) 4987 9344 (6) Personal information

E kate.bennink@des.qld.gov.au

99 Hospital Road, Emerald QLD 4720

PO Box 3028, Emerald QLD 4720

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RTI Act 2009



Department of
Environment and Science

9 May 2019

sch4p4 (6) Personal information
Director – CSIRO Land and Water
Black Mountain Science and Innovation Park,
Clunies Ross Street,
Acton
CANBERRA CITY ACT 2601

sch4p4 (6) Personal information
By email: Personalinfo@csiro.au

sch4p4 (6) Personal information
Dear [redacted]

Thank you for meeting with ~~us~~ representatives from the Department of Environment and Science (the department) on 16 April 2019 to ~~clarify discuss~~ the recommendations provided in the report 'Advice on Groundwater Management and Monitoring and Groundwater Dependent Ecosystem Management plans to the Department of the Environment and Energy (CSIRO and Geoscience Australia, February 2019)'.

~~The department has now reviewed the report and~~ From the meeting on 16 April 2019, the department requests clarification ~~of about the~~ research recommended by CSIRO and Geoscience Australia to provide greater certainty of the source aquifer(s) to the Doongmabulla Springs Complex (DSC).

~~This is based on~~ We specifically note the following points from the report:

~~the recommendation in the Advice report on page 9 point 2 which states –~~
'Available evidence supports the conceptualisation that the Clematis Sandstone is a likely source aquifer for the DSC. However, the proposed monitoring and management approaches do not sufficiently address the uncertainty regarding the potential alternative or additional source aquifers.' (p9); and

'The Advice recommends that to constrain the source aquifer(s) of the DSC, a more sophisticated statistical analysis of hydrochemistry data is required. This includes assessing a wider variety of groundwater and surface water analytes, as well as appropriate use of isotope hydrochemistry analysis. Further information on potential techniques is provided (CSIRO and Geoscience Australia, 2018).' (pX).

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~~The department also notes that in your advice. In the November 2018, Advice on draft research plans~~ to the Department of the Environment and Energy ~~in November 2018 on the draft research plans~~ for Carmichael Coal Mine, ~~the following statements were made:~~

~~on page 5 recommends 'an integrated analysis of existing and newly acquired geological, hydrodynamic and hydrochemical data to improve the conceptual understanding of the groundwater sources of the DSC'. (p5); and~~

~~In conclusion, on page 13, the Advice states the 'need to define the analytical suite, quality assurance and quality control methods, and use a broader range of isotopic and environmental traces' to assess the springs source and groundwater flow processes (p13).~~

~~At the meeting, CSIRO and Geoscience Australia~~The department is of the understanding ~~that the following provided advice detailed a sequential process for undertaking further research could be committed to whereby Adani commit to undertaking further research that includes to improve the certainty about the source aquifer(s) of the DSC:~~

- ~~1. hydrogeochemistry-hydrogeochemical~~ analysis of water samples for comparison within and across relevant aquifers (Clematis Sandstone, Dunda Beds, and Rewan Formation);
- ~~2. incorporating~~ the use of isotope and ageing tracers ~~in the above hydrogeochemical analysis;~~
- ~~3. a comprehensive review of groundwater level and quality data from relevant aquifers;~~
- ~~4. undertake~~ detailed ~~geology-geological~~ mapping including cores from bores drilled in the vicinity of DSC and facies modelling;
- ~~5. incorporating-incorporation of~~ the airborne electro-magnetic modelling recently completed by Geoscience Australia (and available to Adani by June 2020); and
- ~~6. thereby updateexpansion of~~ the conceptual understanding of the source aquifer(s) for DSC for incorporation into the groundwater model review (re-run).

The department requests ~~confirmation and/or review and~~ advice ~~on the above steps, and confirmation~~ as to whether the ~~aboveproposed process~~ adequately details your recommendations and how this would be better detailed to the proponent to ensure a better understanding of the source aquifer(s) of DSC.

~~This-Your advice~~ will enable my staff to consider ~~your recommendations~~the review report in their assessments of the GDMP and GMMP with respect to the relevant environmental authority condition requirements.

~~In order to~~To provide the appropriate context, ~~please find attached~~ the current version of the GDMP ~~(version 11b) as that was~~ submitted ~~to the department~~ on 9 April 2019, ~~is attached~~ and the Research Study Report – Source Aquifer to Doongmabulla Springs, ~~as provide that was provided~~ to the department ~~by Adani~~ in November 2018.

Please do not hesitate to contact me ~~on (07) 4987 9343 or Melissa.wells@des.qld.gov.au~~ should you require further information ~~as about~~ this request, ~~on (07) 49879343 or Melissa.wells@des.qld.gov.au~~

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Commented [BK1]: I think this needs to be more specific

Commented [BK2]: Is it broader than this?

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Yours sincerely

Melissa Wells
Executive Director
Coal and Central Queensland Compliance

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Date : 30/05/2019 5:20:16 PM

From: "(6) Personal information (L&W, Black Mountain)"

To : "MCCOSKER Juliana" , "(6) Personal information (L&W, Black Mountain)" , s.78B(2) @ga.gov.au"

Cc : "WELLS Melissa"

Subject : RE: DES technical contact

Thank you, Juliana.

With regards, (6) Personal information

-----Original Message-----

From: MCCOSKER Juliana [mailto:Juliana.Mccosker@des.qld.gov.au]

Sent: Thursday, 30 May 2019 4:15 PM

To: "(6) Personal information (L&W, Black Mountain)" , "(6) Personal information (L&W, Black Mountain)" , "(6) Personal information (L&W, Black Mountain)" , "(6) Personal information (L&W, Black Mountain)" , s.78B(2) @ga.gov.au

Cc: WELLS Melissa <Melissa.Wells@des.qld.gov.au>

Subject: RE: DES technical contact

Hi (6) Personal information

Please see attached the latest copy of the GMMP submitted by Adani today. Does not include all the appendices.

Ciao for now

Juliana

-----Original Message-----

From: WELLS Melissa <Melissa.Wells@des.qld.gov.au>

Sent: Thursday, 30 May 2019 3:59 PM

To: "(6) Personal information (L&W, Black Mountain)" , "(6) Personal information (L&W, Black Mountain)" , "(6) Personal information (L&W, Black Mountain)" , "(6) Personal information (L&W, Black Mountain)" , s.78B(2) @ga.gov.au

Cc: MCCOSKER Juliana; s.78B(2) @ga.gov.au

Subject: DES technical contact

Hi (6) Personal information

Juliana McCosker (07) 4987 9356 is our technical contact. Happy to arrange Skype or teleconference if that assists with the review or just to provide any clarification.

Kind regards,
Melissa.

Sent from my iPhone

The information in this email together with any attachments is intended only for the person or entity to which it is addressed and may contain confidential and/or privileged material. There is no waiver of any confidentiality/privilege by your inadvertent receipt of this material.
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Date : 15/05/2019 12:14:32 PM

From : s.73

To : "MCCOSKER Juliana", s.73, "WELLS Melissa", s.73, "BENNINK Kate"

Subject : Re: *Holder* Meeting TBC

Attachment : image001.jpg;image047758.jpg;

Hi Juliana and Melissa,

We have developed a comprehensive response to Attachment A which we will table for today's workshop.

Rather than send this through unaccompanied by a discussion, we get it more appropriate and more expedient to take this approach.

The high level issues as per the Agenda can guide us in this discussion.

Kind regards

s.73

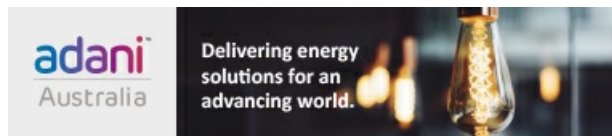
E s.73 adani.com.au

P office: +61 7 3223 4800 | direct: + s.73

A Level 25, 10 Eagle Street, Brisbane, QLD, 4000

P GPO Box 2569, Brisbane, QLD, 4001

W adaniaustralia.com



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On 14 May 2019, at 4:58 pm, s.78B(2) adani.com.au wrote:

s.73

Sent from my iPhone

Hi Juliana

I apologise, I am awaiting some technical advice to come back so I could give you some high level feedback (and unfortunately I have been out of the office).

We have sent through the Agenda to break the discussion down by issue, and we will follow your Attachment A and provide feedback against each item.

I will give you an update on that feedback in the morning.

Kind regards

s.73

s.73

E s.73 @adani.com.au

P office: +61 7 3223 4800 | direct: s.73

A Level 25, 10 Eagle Street, Brisbane, QLD, 4000

P GPO Box 2569, Brisbane, QLD, 4001

W adaniaustralia.com

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From: MCCOSKER Juliana [<mailto:Juliana.Mccosker@des.qld.gov.au>]

Sent: Tuesday, 14 May 2019 4:38 PM

To: [redacted] s.73 [redacted] @adani.com.au>; WELLS Melissa <Melissa.Wells@des.qld.gov.au>; [redacted] s.73 [redacted] adani.com.au>; [redacted] s.73 [redacted] @adani.com.au>; BENNINK Kate <Kate.Bennink@des.qld.gov.au>

Subject: RE: *Holder* Meeting TBC

Hi [redacted] s.78B(2)

Thank you for this, however, could you please advise when Adani is going provide feedback/comments to Attachment of the department letter on 2 May 2019 as committed to last week? My understanding was that these would be provided to us prior to the workshop.

Ciao for now

Juliana

From [redacted] s.73 [redacted] @adani.com.au>

Sent: Tuesday, 14 May 2019 4:18 PM

To: WELLS Melissa; MCCOSKER Juliana; [redacted] s.73 [redacted] BENNINK Kate

Subject: RE: *Holder* Meeting TBC

Good afternoon

Please find attached a draft agenda for our meeting tomorrow afternoon.

If you have any comments or suggested changes, they would be appreciated by 10 am. Apologies for the short notice.

Regards

[redacted] s.73

[redacted] s.73

E [redacted] s.73 [redacted] @adani.com.au

P office: +61 7 3223 4800 | direct: [redacted] s.73

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[redacted] s.73

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-----Original Appointment-----

From: WELLS Melissa [<mailto:Melissa.Wells@des.qld.gov.au>]

Sent: Tuesday, 14 May 2019 2:52 PM

To: WELLS Melissa; [redacted] s.73 [redacted] MCCOSKER Juliana; [redacted] s.78B(2) [redacted] BENNINK Kate

Subject: FW: *Holder* Meeting TBC

When: Wednesday, 15 May 2019 2:30 PM-5:00 PM (UTC+10:00) Brisbane.

Where: Bolsover St Level 2 - Great Keppel Room

-----Original Appointment-----

From: WELLS Melissa [<mailto:Melissa.Wells@des.qld.gov.au>]

Sent: Monday, 13 May 2019 1:17 PM

To: WELLS Melissa; MCCOSKER Juliana; [redacted] s.73 [redacted] BENNINK Kate

Subject: *Holder* Meeting TBC

When: Wednesday, 15 May 2019 2:30 PM-5:00 PM (UTC+10:00) Brisbane.

Where: Bolsover St Level 2 - Great Keppel Room

Date : 9/05/2019 10:00:46 AM
From : "WELLS Melissa"
To : s.73
Cc : s.73 "MCCOSKER Juliana"
Subject : RE: Meeting on Friday 10th May 2019
Attachment : image002.png;image004.jpg;image001.png;

Thanks s.73 confirming tomorrow at 10am level 3, 400 George St.

Looking forward to meeting then.

Kind regards,
Melissa.



Melissa Wells
Executive Director
Coal and Central Qld Compliance
Department of Environment and Science

P 07 4987 9343

99 Hospital Road, Emerald QLD 4720
PO Box 3028, Emerald QLD 4720

From: s.73 @adani.com.au>
Sent: Wednesday, 8 May 2019 5:10 PM
To: WELLS Melissa
Cc: s.73 MCCOSKER Juliana
Subject: Meeting on Friday 10th May 2019

Dear Melissa,

I note that we are meeting with you this Friday 10th May to discuss a number of management plans for the Carmichael Coal project and the proper completion of that process.

With respect to that meeting:

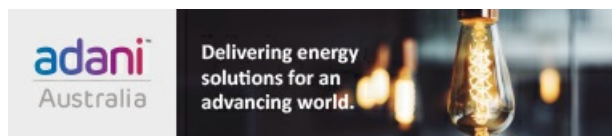
- On the BTFMP, on a forward looking basis we are seeking to obtain clarity from you around matters raised in Attachment A provided to us on 2nd May 2019 and, if we were to do so, how those matters may be incorporated into any revised BTFMP. We are also seeking confirmation of process and timing with respect to the approval process for this plan.
- On the GDEMP, we are awaiting the Department's feedback on Version 9 of this plan, available on our website. We are also seeking confirmation of process and timing with respect to the approval process for this plan.
- On the GMMP, we are awaiting the Department's feedback on Version 7 of this plan as referred to in my email today and available on our website. We are also seeking confirmation of process and timing with respect to the approval process for this plan.

Lastly, can you please confirm the location details for the meeting.

Kind regards,

s.73

E s.73 @adani.com.au
P office: +61 7 3223 4800 | direct: s.73
A Level 25, 10 Eagle Street, Brisbane, QLD, 4000
P GPO Box 2569, Brisbane, QLD, 4001
W adaniaustralia.com



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Date : 8/05/2019 2:22:39 PM

From : "CLAUS Sonia"

To : "BENNINK Kate" , "MCCOSKER Juliana"

Subject : RE: my review of letter

Attachment : Letter to CSIRO-GA clarification 090519 KB_.docx;image001.png;

Hi Juliana

I've added addition track changes to Kate's edits.

Thanks

Sonia

From: BENNINK Kate <Kate.Bennink@des.qld.gov.au>

Sent: Wednesday, 8 May 2019 1:37 PM

To: CLAUS Sonia; MCCOSKER Juliana

Subject: my review of letter

Hi Juliana and Sonia, I've made some edits in tracked changes and asked some questions for consideration. Cheers Kate



Kate Bennink

Director

Business Centre Coal | Coal and Central Queensland
Compliance

Environmental Services and Regulation

Department of Environment and Science

P (07) 4987-9334 **(6)** Personal information

E kate.bennink@des.qld.gov.au

99 Hospital Road, Emerald QLD 4720

PO Box 3028, Emerald QLD 4720



Department of
Environment and Science

9 May 2019

sch4p4(6) Personal information
Director – CSIRO Land and Water
Black Mountain Science and Innovation Park,
Clunies Ross Street,
Acton
CANBERRA CITY ACT 2601

By email (6) Personal information

sch4p4(6) Personal information

Thank you for meeting with ~~us~~ representatives from the Department of Environment and Science (the department) on 16 April 2019 to ~~clarify~~ discuss the ~~recommendations provided in the report~~ 'Advice on Groundwater Management and Monitoring and Groundwater Dependent Ecosystem Management plans to the Department of the Environment and Energy (CSIRO and Geoscience Australia, February 2019)'.

~~The department has now reviewed the report and~~ From the meeting on 16 April 2019, the department requests clarification ~~of about the~~ research recommended by CSIRO and Geoscience Australia to provide greater certainty of the source aquifer(s) to the Doongmabulla Springs Complex (DSC).

~~This is based on~~ We specifically note the following points from the report:

~~the recommendation in the Advice report on page 9 point 2 which states –~~
'Available evidence supports the conceptualisation that the Clematis Sandstone is a likely source aquifer for the DSC. However, the proposed monitoring and management approaches do not sufficiently address the uncertainty regarding the potential alternative or additional source aquifers.' (p9); and

'The Advice recommends that to constrain the source aquifer(s) of the DSC, a more sophisticated statistical analysis of hydrochemistry data is required. This includes assessing a wider variety of groundwater and surface water analytes, as well as appropriate use of isotope hydrochemistry analysis. Further information on potential techniques is provided (CSIRO and Geoscience Australia, 2018).' (p10).

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~~The department also notes that in your advice. In the November 2018, Advice on draft research plans~~ to the Department of the Environment and Energy ~~in November 2018 on the draft research plans~~ for Carmichael Coal Mine, ~~the following statements were made:~~

~~on page 5 recommends 'an integrated analysis of existing and newly acquired geological, hydrodynamic and hydrochemical data to improve the conceptual understanding of the groundwater sources of the DSC'. (p5); and~~

~~In conclusion, on page 13, the Advice states the 'need to define the analytical suite, quality assurance and quality control methods, and use a broader range of isotopic and environmental traces' to assess the springs source and groundwater flow processes (p13).~~

~~At the meeting, CSIRO and Geoscience Australia~~The department is of the understanding ~~that the following provided advice detailed a sequential process for undertaking further research could be committed to whereby Adani commit to undertaking further research that includes to improve the certainty about the source aquifer(s) of the DSC:~~

- ~~1. hydrogeochemistry-hydrogeochemical~~ analysis of water samples for comparison within and across relevant aquifers (Clematis Sandstone, Dunda Beds, and Rewan Formation);
- ~~2. incorporating~~ the use of isotope and ageing tracers ~~in the above hydrogeochemical analysis;~~
- ~~3. a comprehensive review of groundwater level and quality data from relevant aquifers;~~
- ~~4. undertake~~ detailed ~~geology-geological~~ mapping including cores from bores drilled in the vicinity of DSC and facies modelling ~~to better inform hydraulic connectivity within and across all aquifers;~~
- ~~5. incorporating-incorporation of~~ the airborne electro-magnetic modelling recently completed by Geoscience Australia (and available to Adani by June 2020); and
- ~~6. thereby update-expansionrevision of~~ the conceptual understanding of the ~~source aquifer(s) for DSC groundwater system based on information collected from the above~~ for incorporation into the groundwater model review (re-run).

The department requests ~~confirmation and/or review and~~ advice ~~on the above steps, and confirmation~~ as to whether the ~~aboveproposed process~~ adequately details your recommendations and how this would be better detailed to the proponent to ensure a better understanding of the source aquifer(s) of DSC.

~~This-Your advice~~ will enable my staff to consider ~~your recommendations~~the review report in their assessments of the GDEMP and GMMP with respect to the relevant environmental authority condition requirements.

~~In order to~~To provide the appropriate context, ~~please find attached~~ the current version of the GDEMP ~~(version 11b) as that was~~ submitted ~~to the department~~ on 9 April 2019, ~~is attached and the Research Study Report – Source Aquifer to Doongmabulla Springs as provide that was provided~~ to the department ~~by Adani~~ in November 2018.

Please do not hesitate to contact me ~~on (07) 4987 9343 or Melissa.wells@des.qld.gov.au~~ should you require further information ~~as about~~to this request, ~~on (07) 49879343 or Melissa.wells@des.qld.gov.au~~

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Commented [BK1]: I think this needs to be more specific

Commented [CS2R1]: Were you referring to the data that will be collected from the new bores?

Commented [BK3]: Is it broader than this?

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Yours sincerely

Melissa Wells
Executive Director
Coal and Central Queensland Compliance

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Date : 30/05/2019 4:43:23 PM

From : "CLAUS Sonia"

To : "MCCOSKER Juliana"

Subject : RE: re. GDEMP comments

Attachment : Departmental Comments on the GDEMP version 11b_sc comments.docx;image001.png;image003.png;

Hi Juliana

Looks good. I have provided some minor changes and added the Doongmabulla Table at the end of the document.

Thanks

Sonia

From: MCCOSKER Juliana <Juliana.Mccosker@des.qld.gov.au>

Sent: Thursday, 30 May 2019 2:40 PM

To: CLAUS Sonia

Subject: re. GDEMP comments

Hi Sonia,

Can you please review and make sure I have not missed anything critical.

Ciao for now

Juliana



Juliana McCosker

Manager

Business Centre Coal - Coal and Central Queensland Compliance

Department of Environment and Science

P 07 4987 9350 (M) Personal information

99 Hospital Road, Emerald QLD 4720

PO Box 3028, Emerald QLD 4720

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Department of
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Departmental Comments on the GDEMP version 11b

Environmental Authority Holder: Adani Mining Pty Ltd

EA: EPML01470512

Project: Carmichael Coal Mine

Document: Groundwater Dependent Ecosystem Management Plan

EA Conditions: I11 to I14 and definition requirements in Appendix 1

Document Full Title	Groundwater Dependent Ecosystem Management Plan – Carmichael Coal Project submitted 9 April 2019
Delegate	Juliana McCosker
Reviewing Officer	Kate Bennink
Receiving Date	9 April 2019
Background information	<p>This review was completed on the GDEMP version 11b submitted on 9 April 2019</p> <p>In completing this review, consideration was given to the following:</p> <ul style="list-style-type: none">• The GDEMP version 11b received on 9 April 2019. GDEMP Track changes v10 to 11 and GDEMP track changes v11a to v11b.• Independent scientific review Advice from CSIRO and GA received on 9 April 2019. <i>'Advice on Groundwater Management and Monitoring and Groundwater Dependent Ecosystem Management plans to the Department of the Environment and Energy. February 2019.'</i>• Independent scientific review Advice from CSIRO and Geoscience Australia received on 20 November 2018. <i>'Carmichael Coal Mine - Advice on draft research plans to the Department of the Environment and Energy November 2018'.</i>• Summary of that advice and Adani's response prepared by the Department of the Environment and Energy received on 9 April 2019 entitled <i>'Summary of CSIRO and Geoscience Australia Advice on Groundwater Management Plans and Response'.</i>• 16 April 2019, Briefing by CSIRO, GA and DOEE regarding their advice, Adani's response and revisions of groundwater management plans.• Technical advice from DES Water Sciences.

Condition

111 The proponent must develop and implement a Groundwater Dependent Ecosystems Management Plan (GDEMP) to detail the management of threats to defined environmental values and to report results and corrective actions for each GDE over the full period of mining activities and for a period of five years post mining rehabilitation.

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Issue

There are numerous inconsistencies between Sections and Tables when referring to surveys, indicators, parameters and triggers. See detailed examples below.

Due to the inconsistencies throughout the GDEMP, it is recommended that a summary of all the surveys and indicators/parameters that will be monitored for each GDE as part of the GDEMP be included in the GDEMP. This is to ensure that all appropriate data is collected and not overlooked. A revision of the GDEMP should also be done to improve the consistency between and within sections and tables.

It is acknowledged that the triggers and corrective actions may need to be revised after monitoring commences. A commitment to update the GDEMP with proposed triggers for all indicators/parameters after 12 months should be included in the GDEMP.

Recommendation

It is recommended that a revision of the GDEMP is undertaken that ensures consistency between and within sections and tables. This revision should include a summary of all the surveys and indicators/parameters within each GDE section.

Condition

I12 The GDMP must be approved by the administering authority in writing and the GDMP published on a website before the commencement of Project Stage 2.

Issue**Recommendation**

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Condition

I13 For the purposes of conditions I11 and I12, the GDEs include the affected Carmichael River riparian zone (ecosystems associated with the Carmichael River between Doongmabulla Springs and the Belyando River, including populations of Waxy Cabbage Palm), the Lignum, Stories and Mellaluka springs and the Doongmabulla, Spring complex.

Issue

The GDEMP clearly addresses the GDEs as required by Condition I13

Recommendation

No issue

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Condition

114 report of the findings of the GDEMP, including all monitoring results and interpretations, must be prepared annually and made available on request to the administering authority. The report must include:

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- a) an assessment of background reference groundwater levels (see condition E9)
- b) the condition of each GDE compared with previous monitoring results
- c) the suitability of current groundwater trigger thresholds (as defined in condition E13)
- d) detail on the effectiveness of avoidance, mitigation and management actions in curtailing adverse impacts on GDE ecosystems
- e) a description of any adaptive management initiatives implemented
- f) any offsets required for residual impacts

Issue

Due to the inconsistency and lack of trigger values and corrective actions for all indicators in the GDEMP, it will be difficult to report on the condition of each GDE compared with previous monitoring results. It will also be difficult to detail the effectiveness of avoidance, mitigation and management actions in curtailing adverse impacts on GDE ecosystems or any adaptive management initiatives implemented.

Recommendation

DES recommends the GDEMP is updated to include proposed triggers for all indicators/parameters and improve the consistency between and within sections and tables be done as discussed above.

It is acknowledged that the triggers and corrective actions may need to be revised after monitoring commences. A commitment to update the GDEMP with proposed triggers for all indicators/parameters after 12 months should be included in the GDEMP.

Definition requirements

A GDEMP is a plan developed by a suitably qualified and experienced person that is consistent with any Bioregional Management Plan for the bioregion, the Water Resource (Great Artesian Basin) Plan and relevant threat abatement plans, conservation advice and project species management plans.

Issue

Lack of consistency with Waxy Cabbage Palm conservation advice

<http://www.environment.gov.au/biodiversity/threatened/species/pubs/64581-conservation-advice.pdf>

The conservation advice states - Prevent grazing pressure at known sites on leased crown land through exclusion fencing or other barriers.

Recommendation

It is recommended that as a corrective action - grazing is removed from the Carmichael River to prevent trampling and reduction of water supply to waxy cabbage palm populations and ensure consistency with the Conservation Advice.

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Condition

The plan must include a description and map of each GDE potentially or indirectly impacted by mining activities.

Issue

Section 8.1 outlines additional features within the Doongmabulla Spring complex. The location of these new features should be provided on a figure within the GDEMP.

Recommendation

Provide a map/figure that shows the location of the Home Springs, Bonanza Springs Group, Yukunna Kumoo Springs, Dusk Springs, Surprise Springs and the scalded areas around House Springs and Camps Springs where endemic *Trianthema sp.* The additional figure should be referred to in Section 8.1.

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Condition

The plan must include Detailed baseline monitoring (using QuickBird imagery or similar) to be undertaken on the specific ecology of each GDE, groundwater level, groundwater and surface water quality, threatened species and ecosystem function

Issue

Ensure-There is in consistency in terminology when referring to groundwater level throughout the GDEMP. - groundwater level. The is the indicator and should not be is referred to as 'depth to groundwater', for example on as on page 85.

Recommendation

Ensure consistency in terminology when referring to groundwater level.

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Condition

The plan must include Detailed baseline research to establish:

(a) the extent and ecological composition of each GDE, in accordance with the Wetland Monitoring Methodology for springs in the Great Artesian Basin (R. Fensham, 2009) where Applicable

Recommendation

No issue

No Issue

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Condition

The plan must include detailed baseline research to establish the source aquifer(s) for groundwater supply to the GDE

Issue

1. The groundwater monitoring locations within the GDEMP for the Carmichael River are within the alluvium and Clematis Sandstone only. The Tertiary Sediments was identified in the GMMP as a source aquifer to the Carmichael River, therefore groundwater monitoring locations within the Tertiary Sediment should be included in Table 6-7.

In Table 7 – Groundwater Recharge and Discharge Mechanisms page 56 of GMMP - The Tertiary sediment's primary recharge mechanism is via vertical leakage from overlying alluvium and primary discharge mechanism is via vertical leakage to the overlying alluvium.

2. Section 8.3.6 discusses the properties of the Rewan Formation determined to date. However section 8.3.6 does not provide any detail of the baseline research that will be undertaken to evaluate the presence, extent and influence of various structure and stratigraphic characteristics of the Rewan Formation and how these may influence the behaviour of that unit with respect to allowing interconnection between overlying and underlying units.
3. Section 8.3.7 discusses the alternative model scenario where the source of the springs is below the Clematis. However, there is another alternative scenario, that should be discussed in this section, where there is hydraulic connectivity between the geological units below and above the Rewan Formation. This scenario can influence the modelled drawdown. To add confidence to the conceptual model and numerical model, additional work must be completed prior to the model review.
4. To provide greater certainty to the groundwater conceptual model and numerical model, additional work must be completed prior to the model re-run.

Recommendation

1. Provide groundwater monitoring locations within the Tertiary sediment in Table 6-7 Groundwater Monitoring Locations (from the GMMP) page 87 of GDEMP.
2. In section 8.3.6 provide a summary of the baseline research that will be undertaken to determine the presence, extent and influence of the various structure and stratigraphic characteristics of the Rewan Formation and how these influence the behaviour of the unit with respect to allowing interconnection between overlying and underlying units.
3. In section 8.3.7 discuss the potential alternative model scenario where there is hydraulic connectivity between the geological units below and above the Rewan Formation and the potential influence this scenario could have on the predicted drawdown.

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~~3.4~~ To add confidence to the conceptual model and numerical model, additional work must be completed prior to the model review. It is recommended that Adani make the commitment to undertake the following additional work prior to undertaking the Model Re-run as required by Condition E6:

- Hydrochemistry assessment of all bores from all aquifers, springs and the Carmichael River. This should include piper plots or similar analysis to determine source aquifers and interactions between hydrogeological units.
- Analysis of rock properties from the cores of new nested bores to inform hydraulic connectivity within and between hydrogeological units.
- At least 12 sampling units that are not more than 2 months apart over a 2 year period of water level and quality data from the new nested bores as per Condition E3(b).
- Determine the age of groundwater using isotopic racers
- Use soon to be released GA airborne electromagnetic survey data to ascertain hydrogeology in and around the Groundwater Dependent Ecosystems.

~~4. It is recommended that Adani make a commitment to completing the following additional work prior to undertaking the Model re-run as required by Condition E6:~~

- ~~• Hydrochemistry assessment of all bores from all aquifers, springs and the Carmichael River. This should include piper plots or similar analysis to determine source aquifers and interactions between hydrogeological units.~~
- ~~• Analysis of rock properties from the cores of new nested bores to inform hydraulic connectivity within and between hydrogeological units.~~
- ~~• At least 12 sampling units that are not more than 2 months apart over a 2 year period of water level and quality data from the new nested bores as per Condition E3(b).~~
- ~~• Determine the age of groundwater using isotopic racers~~
- ~~• Use soon to be released GA airborne electromagnetic survey data to ascertain hydrogeology in and around the Groundwater Dependent Ecosystems.~~

Condition

The plan must include detailed baseline research to establish the natural variation of the groundwater level/pressure

Issue

Section 8.8 refers to the installation of additional bores.

"The GMMP recommends the installation of additional bores, in order to evaluate the vertical gradients between hydrogeological units. These proposed additional monitoring bores will be completed in the Rewan Formation / Dunda Beds and will also be designated as early warning bores for vertical migration of potential drawdown from the deeper coal measures. They will be co-located, or within 500m of existing Clematis sandstone monitoring locations. (page 211-212)"

Recommendation

Further details regarding the location the new nested bores must ~~also~~ be included in the GDEMP, as per the GMMP.

Provision of a commitment for the timeframe for installation and the location of the bores should be included, as per the GMMP. To determine the natural variation in groundwater level, at least 12 sampling events over a 2 year period, that are no more than 2 months apart, is required during the pre-impact period (as per Condition E3(b)).

Condition

The plan must include detailed baseline research to establish GDE ecosystem pressure response to groundwater level/pressure fluctuation

Recommendation

No issue

~~No issue~~

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Condition

The plan must include a description of how the results of baseline research and annual monitoring are to be used to determine any changes in GDE ecology attributable to mining activities

Issue

1. As the earliest predicted potential impacts are different for each GDE, the timeframes for the completion of pre-impact surveys is not clearly stated.

Table 6-2 for the Carmichael River threats, potential direct/indirect project impacts and matters required to be addressed by conditions and **Table 7-3 – Waxy Cabbage Palm threats, potential direct/indirect project impacts and matters required to be addressed by conditions**. Both tables show that surface water quality degradation and changes to surface water flows and flooding including water discharge are predicted to commence in year 1 of operation.

Table 8-5 Doongmabulla Springs Complex threats, potential direct/indirect project impacts and matters required to be addressed by conditions it is noted that groundwater drawdown from mine dewatering earliest predicted potential impact is year 20 while changes to hydrology will occur from year 1.

Table 9-1 Mellaluka Springs complex – threats, potential direct/indirect project impacts and matters required to be addressed by conditions – it is noted 20 years until potential impacts from groundwater drawdown from mine dewatering and weed and pests through direct competition or habitat degradation.

Appendix C – Chart showing timing of key project element – For the Carmichael River and Waxy Cabbage Palm, both have impacts from clearing to occur in year 10 and groundwater drawdown from mine dewatering to commence impacts in Year 15.

2. Sections 8.7.2 (DSC) and 9.8.1 (Mellaluka Springs) refer to Ecological Condition reports that will be prepared on conclusion of the pre-impact surveys, however no timeframes are provided as to when these reports will be completed. **Section 8.7.3 states 'Impact survey and monitoring will begin from excavation of the first box cut and afterwards for the life of the mine, and for at least five years after mining operations are completed.'**
3. In section 5.5 – Ecological trigger levels. It is unclear how the Ecological triggers for each GDE in this section relate to the attributes listed in Table 5.1 or the indicators listed in each GDE sub plan.
4. Section 8.7.3 – Impact surveys and monitoring – this section does not include groundwater drawdown rates as an indicator.
5. Section 8.7.4 states - *Additional studies to determine the interaction with groundwater and the EWR of the springs and threatened flora species will occur as part of the research program that Adani has committed to.* No detail of what these studies will include is provided.
6. Section 8.7.4 states - *Groundwater modelling will be re-run as new information becomes available as per EA and EPBC Act approval conditions (within 2 years of commencement of mining activities and every 5 years thereafter).* Wording must be consistent with EA – within 2 years after excavation of first box cut.

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Recommendation

1. It is important that the timeframes for the completion of the pre-impact surveys are consistent with timeframes of the predicted potential impacts as detailed in Appendix C and the timeframes are consistent in all the relevant sections of the GDEMP.

2. It is recommended that the reports on the pre-impact surveys for DSC is completed within 12 months of the excavation of first box cut so that the findings can be used to interpret the impact survey results.
3. Provide linkage and consistency when detailing monitoring surveys, monitoring attributes, indicators and parameters throughout the GDEMP.
4. Groundwater drawdown rate thresholds should be as an indicator in section 8.7.3 monitoring for DSC.
5. Provide a summary of the additional studies that Adani has committed to undertaking as part of the research program.
6. Ensure consistency of wording with EA requirements.

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Condition

The plan must include a description of the potential impact on each GDE from each project stage including impacts from subsidence, mine dewatering of aquifers, water discharge, hydrological changes and weed and pest infestation

Issue

1. The department understands that Adani has committed to install an additional 3 gauging stations, in addition to the two existing locations and further surveys to determine height-discharge relationships.

Section 6.6.1 Pre-impact monitoring, Table 6-8 Surface Water Monitoring Locations (from the REMP) and Figure 6-16 Surface Water Monitoring Locations (from the REMP) do not provide any details with respect to the 3 additional gauging stations.

2. In Section 6.3.5 it states 'Aquatic weeds were noted in additional assessments conducted further upstream at the Doongmabulla Springs-complex associated with the Joshua Springs-group'. And in Section 8.1.3 Joshua Springs-group ~~its~~ states 'The Joshua Spring wetlands harbour a Category 3 restricted matter and WoNS Olive Hymenachne, with the outflow channel of the modified spring mound dam choked with this exotic grass.'
3. In Section 8.6 – Mitigation and management measures on page 202- states 'Activities associated with aquifer drawdown are not expected to commence until approximately 2020, with the reduction in pressure of the aquifers expected after approximately 20 years (GHD 2014)'. Is this statement correct or does it need to be qualified to the Clematis aquifer? In Figure 25 of the GMMP shows drawdown occurring after 10 years in the Rewan Formation groundwater bore (C55P1).

Recommendation

1. It is recommended that Adani make a commitment in the GDEMP to install stream gauges to adequately quantify impacts; i.e. One gauging station located where there is peak baseflow pre-impact, one in the area where drawdown prediction is greatest and one downstream where the disconnection in the surface water –groundwater move (25km to 15km downstream) within a stated timeframe.
2. The WoNS Olive Hymenachne warrants inclusion and particular focus for monitoring along the Carmichael River in *Table 6-10 Management objectives, performance criteria, adaptive management triggers and corrective actions for the Carmichael River - row # 7 Weeds and pest plants through direct competition or habitat degradation*. However, it should be noted that eradication at the source location of Joshua Spring outflow would prove to be a more cost-effective strategy).
3. Provide clarification with respect to when the predicted drawdown is to occur in the relevant aquifers associated with Doongmabulla Springs Complex.

Condition

The plan must include Mitigation measures to be undertaken to avoid, mitigate, offset and manage impacts to GDE environmental values resulting from each stage of the project

Issue

In Section 6.4 Threats and impacts (to the Carmichael River) under #1: Groundwater drawdown from mine dewatering in last paragraph on page 58 states *'These changes to groundwater flow will cause the base flow in the Carmichael River to be reduced to zero, via leakage to the ground in 'losing' sections of the river. This means that the isolated pools, which act as refugia for aquatic fauna during dry period, will become less frequent and will eventually dry out. These losing sections are predicted to migrate from 25km downstream of the eastern mining lease boundary pre-construction, to 15km downstream of the eastern mining lease boundary post development... The loss of isolated pools during dry periods could mean that fish and other aquatic fauna will be removed from the reach of stream impacted by aquifer dewatering.'*

In Table 6-10 Management objectives, performance criteria, adaptive management triggers and corrective actions for the Carmichael River with respect to #3 – Changes to surface water levels and flow there are omission that must be addressed to ensure adequate mitigation is achieved to potential impacts on the Carmichael River.

Recommendation

With respect # 3 row – Changes to surface water levels and flows re. The following changes are recommended:

Management actions – An adequate baseline surface flow, quality and level must be determined prior to impacts in the catchment. This includes a detailed understanding of the current losing-gaining nature along the length and response to seasonal variability to ensure goals relating to approved impacts can be assessed and be managed effectively.

Monitoring – Include 3 new gauging stations to adequately quantify impacts – one upstream where there is a peak in baseflow pre-impact, one in the area where groundwater drawdown is greatest and one downstream where the disconnection in surface water-groundwater moves (25km downstream to 15 downstream).

Corrective Action – Removal of grazing (watering by stock) in order to increase water pool life span from Year 20.

Consistency and implementation of the GDEMP

Advice has been provided ~~advice previously~~ on numerous occasions that there was a lack of consistency between sections and tables within the GDEMP.

At the Technical Workshop on Groundwater Management Plan (7/11/2018), the issue of consistency was discussed and the meeting notes state *"Regulators suggested Adani clearly link baseline data and pre-impact monitoring to the monitoring required for both performance criteria and triggers, and also that monitoring was described before the tables with performance criteria, etc."*

Advice was provided on Version 10 ~~with the~~ -main issues identified ~~were as~~ -

- Conceptual model missing Joe Joe Group and Mellaluka Springs.
- The use of *interim* and *initial* trigger levels – it was decided at the meeting (7th Nov) that interim and initial would not be used?
- Consistency in how the groundwater level/drawdown triggers are referred to between sections.
- Consistency between the trigger values in Part 1 and the individual GDE sections is still missing. Also where trigger values are the same, for example between Carmichael River and Waxy Cabbage Palms.
- The Status and Description Section and the Summary of Baseline Monitoring Section could be combined in the individual GDE Sections.
- The Impact Monitoring and Triggers Sections need to be better separated or combined as there is a lot of repetition. For example, if separate Section 6.6.2 should better describe the methodology to monitor the indicators and Section 6.7 should outline the triggers and how they would be applied.
- Approach to statistical analysis table is missing in the Carmichael GDE section.
- The link between the indicators and statistical analysis table and the Management objectives table is needed in each GDE section.
- Groundwater quality trigger levels have not been included in the Appendices.

A revised version dated 20/11/2018 was reviewed with comments provided to Adani on -21/12/2018 which again identified that there was a lack of consistency between the statistical analysis and corrective action tables for each GDE. Specific comments on the surface and groundwater quantity and quality aspects of the tables was provided as an example of the level of consistency that was required throughout the GDEMP (not just when referring to surface and groundwater quality). This long standing issue is still to be addressed.

The issue of consistency within and between sections is important to meet the objectives of the GDEMP (page 1-2), in particular:

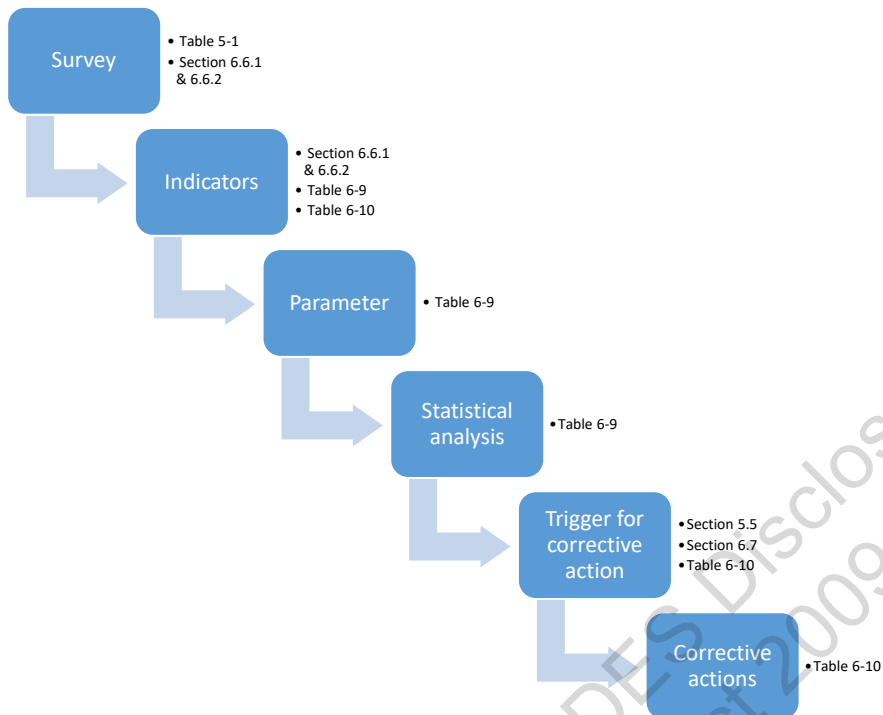
- Detail the monitoring program for both pre-impact and impact phases of the project, including how this monitoring will inform relevant mitigation, management and offset measures
- Describe mitigation and management measures with specific criteria, timing, performance objectives, goals and corrective measures.

It is stated on page 6 of the GDEMP that each management sub-plan in the GDEMP is structured to provide information in a consistent format on:

- Proposed monitoring program for the GDE across the pre-impact and impact stages
- Proposed triggers for both groundwater and ecological values of the GDE
- Details of mitigation and management measures to be implemented, including corrective actions.

Carmichael River sub plan is used as an example of the inconsistencies between Sections and Tables when referring to surveys, indicators, parameters and triggers. **See A comparison Table at the end of this response document has also been provided for Carmichael River and Doongmabulla springs.**

The linkage between the information provided in the GDEMP.



The ecological trigger levels that will be applied in the GDEMP are summarised in Section 5.5. However, this is not consistent with other sections within the report. The indicators that are listed in Section 6.6.1 and 6.6.2 for the Carmichael River are not the same as the indicators listed in Table 5-1 or Table 6-9. In addition, there are indicators in Table 6-10 which are not included in Section 6.6.1, 6.6.2 or Table 6-9. Ecological triggers in Table 6-10 should be provided for each indicator.

The indicators listed in Sections 6.6.1 and 6.6.2 are:

- Population structure
- Community condition
- Weeds and pests or weed cover and pests
- Riparian community health
- Fauna use of riparian habitat
- Canopy cover
- Wetland vegetation
- Threatened and endemic flora populations
- Spring wetland extent
- Groundwater level
- surface water level
- surface water flow
- Groundwater quality
- surface water quality
- presence of weed species
- extent of weed coverage
- presence of pest species
- extent of pest disturbance.

The list of indicators in Table 6-9 are:

- Riparian community health
- Fauna use of riparian habitat
- Weed and pests (within areas controlled by Adani)
- Groundwater Level
- Groundwater Quality
- Surface Water Flow (periods of flow)
- Surface Water Level (periods of no flow)
- Surface Water Quality.

The list of indicators in Table 6-10 are:

- | | |
|--|--|
| <ul style="list-style-type: none"> • Groundwater Level • Groundwater Quality • Surface Water Flow (periods of flow) • Surface Water Level (periods of no flow) • Surface Water Quality • Early warning signs of subsidence, such as tilt, strain and displacement exceeding predictions at monitoring locations. • Observations of cracking or ponding in the Carmichael River. • Visual record • pH • Turbidity • CORVEG attributes • Canopy cover • Visual evidence of disturbance or clearing • Ecological survey indicators • Area cleared • Population structure • Community condition | <ul style="list-style-type: none"> • Riparian community health • Fauna use of riparian habitat • Wetland vegetation • Threatened and endemic flora populations • Canopy cover • Rehabilitation success parameters as listed in Appendix 2 of the EA (native fauna species, plant regeneration, weed abundance, pest abundance), erosion • Fuel load levels and ground composition. • Presence of weed species • Extent of weed coverage • Presence of feral animals • Extent of damage from feral animals • Visual observation and records • Event monitoring for: dB(A) • peak particle velocity (PPV) • Event monitoring for: Total suspended particulate matter • Observations of amount of light falling on Carmichael River |
|--|--|

It maybe that a number of indicators listed in Sections 6.6.1 and 6.6.2 are classed as parameters in Table 6-9. However, this is not the case for community condition or population structure. In addition, wetland vegetation, threatened and endemic flora populations and spring wetland extent are not listed in Table 6-9 but are included in Section 6.6.

In Section 6.6.1, the indicator of population structure is included in the riparian condition and aquatic ecology surveys. However, this indicator will measure different communities and this is not addressed in Table 6-9.

For example, early warning signs of subsidence and cracking and ponding in the Carmichael River are included as an indicator in Table 6-10 but not in the other sections. For indicators included in Table 6-10, that are not other sections above, it is important that the appropriate management plan be referred to in each case.

Threats and potential direct/indirect project impacts that are required to be addressed, as they apply to the Carmichael River, are identified Section 6.4 and listed below.

#	Potential Threat or Impact
1	Groundwater drawdown from mine dewatering
2	Subsidence from underground mining
3	Changes to surface water flows and flooding, including water discharge
4	Surface water quality degradation
5	Vegetation clearing and habitat loss, of approximately 5 hectares to build a bridge across the Carmichael River
6	Fire
7	Weeds and pest
8	Earthworks
9	Noise and vibration
10	Emissions (including dust)
11	Light spill and other visual impacts

Blank cells suggest information is missing. Red text suggests that consistency with terminology is required.

GDE	Monitoring survey	Table 5-1 - Monitoring attributes or methods	Section 5.5 – Ecological triggers	Indicators from Section 6.6.1 – pre impact	Indicators from Section 6.6.2 - impact	Table 6-9 - indicator	Table 6-9 - Parameter	Relevant Table 6-10 Number	Suggested relevant Table 6-10 number
Carmichael River	Ecological features map of the Carmichael River	Threatened and endemic flora locations	Change in the presence of native flora species recorded at monitoring sites located in the riparian zone of the Carmichael River from ecology surveys completed in Spring and Autumn 2011						#5
		Weed and pest locations		Weeds and pests					#7
		Riparian vegetation composition and health		Riparian community health Population structure Community composition (assumed equivalent)				#5	#1, #3, #4, #5
		Fauna use of riparian habitat		Fauna use of riparian habitat					#5
		Areas of connectivity or disconnection with groundwater							#1
		Gaining / losing areas relative to groundwater							#1
		Location of deep pools							#1, #3
		Location of riffles							#1, #3
		Location and size of aquatic macrophyte beds							#1, #3
		Other key aquatic habitat features							#1, #3
	Riparian condition surveys	CORVEG and/or BioCondition surveys	Reduction in riparian forest canopy cover as determined from analysis of aerial photography from period 2010 to 2018.	Riparian community health Population structure Community composition Canopy cover (assumed equivalent)	Riparian community health	Riparian community health	Structural formation, leaf litter cover, rock cover, bare ground, cryptogram cover, crown cover, species composition and cover (by species and by stratum), height of each strata, cover of coarse woody debris, number of	#5	#1, #3, #4, #5

GDE	Monitoring survey	Table 5-1 - Monitoring attributes or methods	Section 5.5 – Ecological triggers	Indicators from Section 6.6.1 – pre impact	Indicators from Section 6.6.2 - impact	Table 6-9 - indicator	Table 6-9 - Parameter	Relevant Table 6-10 Number	Suggested relevant Table 6-10 number
			Riparian community health indicators (CORVEG and BioCondition data) deviate from baseline and pre-impact conditions				large trees (eucalypt and non-eucalypt), diameter at breast height (DBH) of eucalypt and non- eucalypt trees, weed cover, erosion and severity, disturbances and severity, stem count for woody vegetation, basal area.		
				Weed cover and pests				#7	#7
				Fauna use of riparian habitat	Fauna use of riparian habitat	Fauna use of riparian habitat	Abundance of key species.		#5
				Wetland vegetation (unclear why this is included here)					Delete
				Groundwater level (described in text, but not included in list for pre-impact but included in impact)	Groundwater level				#1
	Aquatic Ecological Surveys	Vertebrate species presence, in particular at remnant pools		Population structure (assumed equivalent)					#1, #3, #4, #5
		Ecological condition (e.g. using AusRivAS)	Macro-invertebrate sampling using AusRivAS methods - EPT (Ephemeroptera, Plecoptera and Trichoptera) ratios of macroinvertebrates fall below baseline values of 6.7% (Autumn) and 15.8% (Spring)	Community condition (assumed equivalent)					#1, #3, #4, #5
		Ecological patterns (macrophytes, fish, invertebrates)		Population structure (assumed equivalent)					#1, #3, #4, #5
				Weeds and pests					#7
				Riparian community health					Delete

GDE	Monitoring survey	Table 5-1 - Monitoring attributes or methods	Section 5.5 – Ecological triggers	Indicators from Section 6.6.1 – pre impact	Indicators from Section 6.6.2 - impact	Table 6-9 - indicator	Table 6-9 - Parameter	Relevant Table 6-10 Number	Suggested relevant Table 6-10 number
				(unclear why included in this survey)					
				Fauna use of riparian habitat (unclear why included in this survey)					Delete
				Spring wetland extent (unclear why included in this survey)					Delete
				Wetland vegetation (unclear why included in this survey)					Delete
		Ecological patterns (macrophytes, fish, invertebrates)		Threatened and endemic flora locations (macrophytes)?					?
	Groundwater monitoring	Groundwater level and quality		Groundwater level	Groundwater level	Groundwater level	Groundwater level	#1	#1
				Groundwater quality	Groundwater quality	Groundwater quality	Water quality parameters as outlined in GMMP.	#1, #4	#1, #4
					Groundwater drawdown rate should be included as an indicator				#1
	Surface water monitoring	Surface water level, flow and quality		Surface water level	Surface water level	Surface Water Level (periods of no flow)	Surface Water Level (periods of no flow)	#1, #3	#1, #3
				Surface water flow	Surface water flow	Surface Water Flow (periods of flow)	River discharge	#1, #3	#1, #3
				Surface water quality	Surface water quality	Surface water quality	Water quality parameters as outlined in REMP.	#1, #3, #4	#1, #3, #4
	Weed and pest surveys	Presence of weed species and extent of coverage	Weed species recorded at riparian monitoring sites on the Carmichael River that did not have that weed species recorded during	presence of weed species	presence of weed species	Weed and pests (within areas controlled by Adani)	Inventory of all weed and pest species present. Identify spatial extent of weeds, especially Rubber Vine, along the	#7	#7

GDE	Monitoring survey	Table 5-1 - Monitoring attributes or methods	Section 5.5 – Ecological triggers	Indicators from Section 6.6.1 – pre impact	Indicators from Section 6.6.2 - impact	Table 6-9 - indicator	Table 6-9 - Parameter	Relevant Table 6-10 Number	Suggested relevant Table 6-10 number
			ecology surveys completed in Spring and Autumn 2011.				Carmichael River. Identify areas of Riparian habitat subject to pig damage. (this should be more than just pig damage)		
			Identification of new weed or pest species at any location along the riparian zone of the Carmichael River						
			New population or area affected by weed or pests	extent of weed coverage	extent of weed coverage			#7	#7
		Presence of pest species and extent of disturbance	New population or area affected by weed or pests	presence of pest species	presence of pest species			#7	#7
			Identification of new weed or pest species at any location along the riparian zone of the Carmichael River.						
			New population or area affected by weed or pests	extent of pest disturbance	extent of pest disturbance			#7	#7

GDE	Monitoring survey	Table 5-1 - Monitoring attributes or methods	Section 5.5 – Ecological triggers	Indicators from Section 8.7.1 – pre impact	Indicators from Section 8.7.3 - impact	Table 8-9 - indicator	Table 8-9 - Parameter	Relevant Table 8-10 Number	Suggested relevant Table 8-10 number
Doongmab ulla Spring complex	Spring Monitoring	Spring-head pressure							1
		Flow rate (if measureable)		Flow rate (surface water monitoring)	Spring flow				1
	Mound Springs data	Mound springs diameter, height and perimeter	Deviation from baseline conditions of mound springs characteristics (maximum diameter, height, perimeter length, full floristics species composition)	Mound springs – no indicators specified					1

GDE	Monitoring survey	Table 5-1 - Monitoring attributes or methods	Section 5.5 – Ecological triggers	Indicators from Section 8.7.1 – pre impact	Indicators from Section 8.7.3 - impact	Table 8-9 - indicator	Table 8-9 - Parameter	Relevant Table 8-10 Number	Suggested relevant Table 8-10 number
			and abundance, abundance of spring endemic flora species, abundance of threatened species)						
		Full floristic species composition and abundances	Deviation from baseline conditions of mound springs characteristics	Mound springs – no indicators specified					1, 6
		Population surveys for spring endemic flora species	Absence of GAB spring endemic species observed in Moses Spring in 2012 and 2013 baseline surveys	Mound springs – no indicators specified					1, 6
		Population surveys for Commonwealth and State listed species	Deviation from baseline conditions of mound springs characteristics	Mound springs – no indicators specified					1, 6
		Photographic references (photo point monitoring)		Mound springs – no indicators specified					1
	Wetland vegetation monitoring	Identify wetland zones and their boundary locations	Reduction in wetland area as determined from analysis of aerial photography from period 2010 to 2018.	Spring wetland extent (habitat features survey) (assumed equivalent)			Perennial wetland cover assessed both on site and via remote sensing.	5	1
		Photographic references (photo point monitoring)					Photographic reference		1
		Wetland vegetation species composition	Deviation from baseline conditions of wetland vegetation characteristics (area of wetland zones, vegetation species composition and vegetation species abundance)	wetland vegetation zone native vegetation cover (assumed equivalent)		Wetland vegetation species composition	Identify wetland zones (pool, saturated, damp, dry) and their boundary locations. Wetland vegetation species composition	1, 6	

GDE	Monitoring survey	Table 5-1 - Monitoring attributes or methods	Section 5.5 – Ecological triggers	Indicators from Section 8.7.1 – pre impact	Indicators from Section 8.7.3 - impact	Table 8-9 - indicator	Table 8-9 - Parameter	Relevant Table 8-10 Number	Suggested relevant Table 8-10 number
		Wetland vegetation species abundances	Deviation from baseline conditions of wetland vegetation characteristics (area of wetland zones, vegetation species composition and vegetation species abundance)			Wetland vegetation species abundances	Wetland vegetation Species abundances (1 m x 1 m subplots spaced 4 m apart, along the transect)		1, 6
	Threatened and endemic flora populations	Targeted surveys for threatened and endemic flora populations at each spring head in the Moses Springs-group and each springs wetland	Deviation from baseline conditions in the number and abundance of threatened and endemic flora species	Threatened and endemic species presence, condition and location	Threatened and endemic species presence, condition and location	Threatened and endemic flora populations	Location, extent and condition of <ul style="list-style-type: none"> Waxy Cabbage Palm <i>Livistona lanuginosa</i> (Vulnerable – Moses) Blue Devil <i>Eryngium fontanum</i> (Endangered - Moses) Salt pipewort <i>Eriocaulon carsonii</i> subsp. <i>Oriente</i> (Endangered – Moses) <i>Hydrocotyle dipleura</i> (Vulnerable - Moses) <i>Isotoma</i> sp. 'RJ Fensham 3883' (Endemic – Moses) <i>Myriophyllum artesium</i> (Endangered – Moses and Joshua) <i>Sporobolus pamela</i> (Endangered – Moses) <i>Sporobolus partimpatens</i> (Near Threatened – Moses and Joshua) Any other flora identified during baseline surveys as endemic or threatened, and reliant on GAB spring wetlands for survival. 	1, 6	

GDE	Monitoring survey	Table 5-1 - Monitoring attributes or methods	Section 5.5 – Ecological triggers	Indicators from Section 8.7.1 – pre impact	Indicators from Section 8.7.3 - impact	Table 8-9 - indicator	Table 8-9 - Parameter	Relevant Table 8-10 Number	Suggested relevant Table 8-10 number
	Aquatic invertebrate communities	Characterisation of aquatic macroinvertebrate communities	Deviation from baseline conditions of aquatic invertebrate communities (utilising AusRivAS protocols).						1
		Macroinvertebrate genera and species richness		Macroinvertebrate genera and species richness				1	
	Stygofauna	Stygofauna presence and endemism		Stygofauna presence, stygofauna endemism				1	
	Groundwater monitoring	Groundwater level and quality		Groundwater level	Groundwater level	Groundwater level	Groundwater level	1	
				Groundwater quality	Groundwater quality	Groundwater quality	Water quality parameters as outlined in GMMP.	1	
				Groundwater drawdown rate should be included as an indicator					1
	Surface water monitoring	Spring wetland extent and water level	Deviation from baseline Spring wetland extent	Spring wetland extent (habitat features survey) (assumed equivalent)	Wetland extent (assumed equivalent)	Spring wetland extent	Perennial wetland cover assessed both on site and via remote sensing. Identify wetland zones (pool, saturated, damp, dry) and their boundary locations. Photographic reference	1	
				Spring wetland water level Wetland pool depth	Wetland level (assumed equivalent)			1	
		Surface water quality		Surface water quality	Surface water quality			2, 7	
				Flow rates				2	
	Weed and pest surveys	Presence of weed species and extent of coverage	Weed species recorded at riparian monitoring sites on the Carmichael River that did not have that weed species recorded during ecology surveys	presence of weed species	presence of weed species			4	

GDE	Monitoring survey	Table 5-1 - Monitoring attributes or methods	Section 5.5 – Ecological triggers	Indicators from Section 8.7.1 – pre impact	Indicators from Section 8.7.3 - impact	Table 8-9 - indicator	Table 8-9 - Parameter	Relevant Table 8-10 Number	Suggested relevant Table 8-10 number
			completed in Spring and Autumn 2011. Identification of new weed or pest species at any location along the riparian zone of the Carmichael River						
			New population or area affected by weed or pests	extent of weed coverage	extent of weed coverage			4	
		Presence of pest species and extent of disturbance	New population or area affected by weed or pests Identification of new weed or pest species at any location along the riparian zone of the Carmichael River.	presence of pest species	presence of pest species			4	
			New population or area affected by weed or pests	extent of pest disturbance	extent of pest disturbance			4	

Date : 31/05/2019 2:24:16 PM

From : "CLAUS Sonia"

To : "MCCOSKER Juliana"

Subject : RE: re. GDEMP comments

Attachment : image001.png;image003.png;

How did you want me to provide comments on the GMMP. I could add a column to their table. Do you have a word version?

From: MCCOSKER Juliana <Juliana.Mccosker@des.qld.gov.au>

Sent: Friday, 31 May 2019 8:12 AM

To: CLAUS Sonia

Subject: RE: re. GDEMP comments

Hi Sonia,

Thank you. Will give you a call today to discuss.

Ciao for now

Juliana

From: CLAUS Sonia <Sonia.Claus@des.qld.gov.au>

Sent: Thursday, 30 May 2019 4:43 PM

To: MCCOSKER Juliana

Subject: RE: re. GDEMP comments

Hi Juliana

Looks good. I have provided some minor changes and added the Doongmabulla Table at the end of the document.

Thanks

Sonia

From: MCCOSKER Juliana <Juliana.Mccosker@des.qld.gov.au>

Sent: Thursday, 30 May 2019 2:40 PM

To: CLAUS Sonia

Subject: re. GDEMP comments

Hi Sonia,

Can you please review and make sure I have not missed anything critical.

Ciao for now

Juliana



Juliana McCosker

Manager

Business Centre Coal - Coal and Central Queensland Compliance

Department of Environment and Science

P 07 4987 9984 M 06) Personal information

99 Hospital Road, Emerald QLD 4720

PO Box 3028, Emerald QLD 4720

Date : 31/05/2019 2:26:53 PM
From : "CLAUS Sonia"
To : "MCCOSKER Juliana"
Subject : RE: re. GDEMP comments
Attachment : image001.png;image003.png;
I have a meeting now until 3:30. But free after that.

From: MCCOSKER Juliana <Juliana.Mccosker@des.qld.gov.au>
Sent: Friday, 31 May 2019 2:26 PM
To: CLAUS Sonia
Subject: RE: re. GDEMP comments

Alas not. Will call you shortly.

Ciao for now

Juliana

From: CLAUS Sonia <Sonia.Claus@des.qld.gov.au>
Sent: Friday, 31 May 2019 2:24 PM
To: MCCOSKER Juliana
Subject: RE: re. GDEMP comments

How did you want me to provide comments on the GMMP. I could add a column to their table. Do you have a word version?

From: MCCOSKER Juliana <Juliana.Mccosker@des.qld.gov.au>
Sent: Friday, 31 May 2019 8:12 AM
To: CLAUS Sonia
Subject: RE: re. GDEMP comments

Hi Sonia,

Thank you. Will give you a call today to discuss.

Ciao for now

Juliana

From: CLAUS Sonia <Sonia.Claus@des.qld.gov.au>
Sent: Thursday, 30 May 2019 4:43 PM
To: MCCOSKER Juliana
Subject: RE: re. GDEMP comments

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Juliana



Juliana McCosker
Manager
Business Centre Coal - Coal and Central Queensland Compliance
Department of Environment and Science
P 07 4987 9354 (M) Personal information
99 Hospital Road, Emerald QLD 4720
PO Box 3028, Emerald QLD 4720

Date : 31/05/2019 8:11:38 AM
From : "MCCOSKER Juliana"
To : "CLAUS Sonia"
Subject : RE: re. GDEMP comments
Attachment : image001.png;image002.png;
Hi Sonia,

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Ciao for now

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Juliana



Juliana McCosker
Manager
Business Centre Coal - Coal and Central Queensland Compliance
Department of Environment and Science
P 07 4987 3344 (M) Personal information
99 Hospital Road, Emerald QLD 4720
PO Box 3028, Emerald QLD 4720

Date : 31/05/2019 2:26:06 PM
From : "MCCOSKER Juliana"
To : "CLAUS Sonia"
Subject : RE: re. GDEMP comments
Attachment : image001.png;image002.png;
Alas not. Will call you shortly.

Ciao for now

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Sent: Friday, 31 May 2019 2:24 PM
To: MCCOSKER Juliana
Subject: RE: re. GDEMP comments

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Sent: Friday, 31 May 2019 8:12 AM
To: CLAUS Sonia
Subject: RE: re. GDEMP comments

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Subject: RE: re. GDEMP comments

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Sent: Thursday, 30 May 2019 2:40 PM
To: CLAUS Sonia
Subject: re. GDEMP comments

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Ciao for now

Juliana



Juliana McCosker
Manager
Business Centre Coal - Coal and Central Queensland Compliance
Department of Environment and Science
P 07 4987 9354 M 06 Personal information
99 Hospital Road, Emerald QLD 4720
PO Box 3028, Emerald QLD 4720

Date : 31/05/2019 2:27:29 PM
From : "MCCOSKER Juliana"
To : "CLAUS Sonia"
Subject : RE: re. GDEMP comments
Attachment : image001.png;image002.png;
Ok – talk then.

Ciao for now

Juliana

From: CLAUS Sonia <Sonia.Claus@des.qld.gov.au>
Sent: Friday, 31 May 2019 2:27 PM
To: MCCOSKER Juliana
Subject: RE: re. GDEMP comments

I have a meeting now until 3:30. But free after that.

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Sent: Friday, 31 May 2019 2:26 PM
To: CLAUS Sonia
Subject: RE: re. GDEMP comments

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To: MCCOSKER Juliana
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To: CLAUS Sonia
Subject: RE: re. GDEMP comments

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Juliana

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Sent: Thursday, 30 May 2019 4:43 PM
To: MCCOSKER Juliana
Subject: RE: re. GDEMP comments

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Sent: Thursday, 30 May 2019 2:40 PM
To: CLAUS Sonia
Subject: re. GDEMP comments

Hi Sonia,

Can you please review and make sure I have not missed anything critical.

Ciao for now

Juliana



Juliana McCosker

Manager

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Department of Environment and Science

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99 Hospital Road, Emerald QLD 4720

PO Box 3028, Emerald QLD 4720

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RTI Act 2009

Date : 24/05/2019 4:09:12 PM

From : "MCCOSKER Juliana"

To : "CLAUS Sonia"

Subject : Re: WRNB ID 2323 - Work Request Response - GDEMP comments : Other - GDEMP Review - Adani Mining Pty Ltd - Carmichael Coal Mine

Thank you, Sonia. Will call on Monday to discuss.

Ciao for now

Juliana

Sent from my iPhone

On 24 May 2019, at 4:07 pm, CLAUS Sonia <Sonia.Claus@des.qld.gov.au> wrote:

Service Group: Water (WAS)
Request Task: Other - GDEMP Review
Proponent / Company: Adani Mining Pty Ltd
Facility Name: Carmichael Coal Mine
Facility Location: Galilee Basin
Project File Details: 101/0005439-002
Date of Request: 20/05/2019 12:00:00 AM
Due Date of Request: 13/06/2019 12:00:00 AM
Urgency: Normal
Client Region: Central Region
Category: Mining

Hi Juliana

I have attached my comments on the GDEMP. I have put each comment under what I think is the most appropriate EA condition or GDEMP definition.

Let me know if you have any questions.

Thanks

Sonia

--

Sonia Claus

Email: Sonia.Claus@des.qld.gov.au

To view more information about this work request visit: [More Info](#)

Request Summary

Service Group	Water (WAS)		
Status	InProgress	Hours Worked	7.5
Request Task	Other - GDEMP Review	Proponent / Company	Adani Mining Pty Ltd
Facility Name	Carmichael Coal Mine	Facility Location	Galilee Basin
Project File Details	101/0005439-002	Date of Request	20/05/2019 12:00:00 AM
Due Date of Request	13/06/2019 12:00:00 AM	Urgency	Normal
Client Region	Central Region	Category	Mining

Requesting Officer

First Name	Juliana	Last Name	McCosker
Phone	4987 9356	Office	Emerald
Region	Central	Position	Manager
Email	Juliana.Mccosker@des.qld.gov.au		

Manager

Manager First Name	Juliana	Manager Last Name	McCosker
Phone	4987 9356	Office	Emerald

Manager Phone	4987 9356	Manager Position	Manager
Manager Email	Juliana.Mccosker@des.qld.gov.au		

Request Details

Review of Adani proposed GDE MP.

Relevant Documents

Justification

x

Other

Budget Availability	NA	Previous Contacts	Sonia Claus
---------------------	----	-------------------	-------------

Attachments

<WRNB 2278 GDEMP_Final.docx>

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Date : 23/05/2019 2:39:28 PM
From : "MCCOSKER Juliana"
To : "ELLWOOD Dean" , "WELLS Melissa"
Subject : re. BTFMP and GDEMP
Attachment : image001.png;image003.png;
Hi Dean and Melissa,

Please note, as the delegate for the approvals of the Black-throated Finch Management Plan and the Groundwater Dependent Ecosystem Management Plan and in accordance with the environmental authority requirements for Carmichael Coal Mine, any required potential commitments for additional work will not preclude the commencement of Project stage 2 activities at the mine site.

Ciao for now

Juliana



Juliana McCosker
Manager
Business Centre Coal - Coal and Central Queensland Compliance
Department of Environment and Science
P 07 4987 9346
99 Hospital Road, Emerald QLD 4720
PO Box 3028, Emerald QLD 4720

Published on DES Disclosure Log
RTI Act 2009

Date : 31/05/2019 4:23:12 PM

From : "MCCOSKER Juliana"

To : s.73

Subject : re. GDEMP comments

Attachment : Departmental Comments on the GDEMP version 11b 31052019.docx;image001.png;image002.png;

Hi s.73

Please see attached.

Ciao for now

Juliana



Juliana McCosker

Manager

Business Centre Coal - Coal and Central Queensland Compliance

Department of Environment and Science

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99 Hospital Road, Emerald QLD 4720

PO Box 3028, Emerald QLD 4720

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Departmental Comments on the GDEMP version 11b

Environmental Authority Holder: Adani Mining Pty Ltd

EA: EPML01470512

Project: Carmichael Coal Mine

Document: Groundwater Dependent Ecosystem Management Plan

EA Conditions: I11 to I14 and definition requirements in Appendix 1



Department of
Environment and Science

Document Full Title	Groundwater Dependent Ecosystem Management Plan – Carmichael Coal Project submitted 9 April 2019
Delegate	Juliana McCosker
Reviewing Officer	Kate Bennink
Receiving Date	9 April 2019
Background information	<p>This review was completed on the GDEMP version 11b submitted on 9 April 2019</p> <p>In completing this review, consideration was given to the following:</p> <ul style="list-style-type: none">• The GDEMP version 11b received on 9 April 2019. GDEMP Track changes v10 to 11 and GDEMP track changes v11a to v11b.• Independent scientific review Advice from CSIRO and GA received on 9 April 2019. <i>'Advice on Groundwater Management and Monitoring and Groundwater Dependent Ecosystem Management plans to the Department of the Environment and Energy. February 2019.'</i>• Independent scientific review Advice from CSIRO and Geoscience Australia received on 20 November 2018. <i>'Carmichael Coal Mine - Advice on draft research plans to the Department of the Environment and Energy November 2018'.</i>• Summary of that advice and Adani's response prepared by the Department of the Environment and Energy received on 9 April 2019 entitled <i>'Summary of CSIRO and Geoscience Australia Advice on Groundwater Management Plans and Response'.</i>• 16 April 2019, Briefing by CSIRO, GA and DOE regarding their advice, Adani's response and revisions of groundwater management plans.• Technical advice from DES Water Sciences.

Condition

I11 The proponent must develop and implement a Groundwater Dependent Ecosystems Management Plan (GDEMP) to detail the management of threats to defined environmental values and to report results and corrective actions for each GDE over the full period of mining activities and for a period of five years post mining rehabilitation.

Issue

There are numerous inconsistencies between Sections and Tables when referring to surveys, indicators, parameters and triggers. See detailed examples below.

Due to the inconsistencies throughout the GDEMP, it is recommended that a summary of all the surveys and indicators/parameters that will be monitored for each GDE as part of the GDEMP be included in the GDEMP. This is to ensure that all appropriate data is collected and not overlooked. A revision of the GDEMP should also be done to improve the consistency between and within sections and tables.

It is acknowledged that the triggers and corrective actions may need to be revised after monitoring commences. A commitment to update the GDEMP with proposed triggers for all indicators/parameters after 12 months should be included in the GDEMP.

Recommendation

It is recommended that a revision of the GDEMP is undertaken that ensures consistency between and within sections and tables. This revision should include a summary of all the surveys and indicators/parameters within each GDE section.

Condition

I12 The GDEMP must be approved by the administering authority in writing and the GDEMP published on a website before the commencement of Project Stage 2.

No Issue

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Condition

I13 For the purposes of conditions I11 and I12, the GDEs include the affected Carmichael River riparian zone (ecosystems associated with the Carmichael River between Doongmabulla Springs and the Belyando River, including populations of Waxy Cabbage Palm), the Lignum, Stories and Mellaluka springs and the Doongmabulla, Spring complex.

Issue

The GDEMP clearly addresses the GDEs as required by Condition I13

Recommendation

No issue

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Condition

I14 report of the findings of the GDEMP, including all monitoring results and interpretations, must be prepared annually and made available on request to the administering authority. The report must include:

- a) an assessment of background reference groundwater levels (see condition E9 should be E13)
- b) the condition of each GDE compared with previous monitoring results
- c) the suitability of current groundwater trigger thresholds (as defined in condition E13)
- d) detail on the effectiveness of avoidance, mitigation and management actions in curtailing adverse impacts on GDE ecosystems
- e) a description of any adaptive management initiatives implemented
- f) any offsets required for residual impacts

Issue

Due to the inconsistency and lack of trigger values and corrective actions for all indicators in the GDEMP, it will be difficult to report on the condition of each GDE compared with previous monitoring results. It will also be difficult to detail the effectiveness of avoidance, mitigation and management actions in curtailing adverse impacts on GDE ecosystems or any adaptive management initiatives implemented.

Recommendation

DES recommends the GDEMP is updated to include proposed triggers for all indicators/parameters and improve the consistency between and within sections and tables be done as discussed above.

It is acknowledged that the triggers and corrective actions may need to be revised after monitoring commences. A commitment to update the GDEMP with proposed triggers for all indicators/parameters after 12 months should be included in the GDEMP.

Definition requirements

A GDEMP is a plan developed by a suitably qualified and experienced person that is consistent with any Bioregional Management Plan for the bioregion, the Water Resource (Great Artesian Basin) Plan and relevant threat abatement plans, conservation advice and project species management plans.

Issue

Lack of consistency with Waxy Cabbage Palm conservation advice

<http://www.environment.gov.au/biodiversity/threatened/species/pubs/64581-conservation-advice.pdf>

The conservation advice states - Prevent grazing pressure at known sites on leased crown land through exclusion fencing or other barriers.

Recommendation

It is recommended that as a corrective action - grazing is removed from the Carmichael River to prevent trampling and reduction of water supply to waxy cabbage palm populations and ensure consistency with the Conservation Advice.

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Condition

The plan must include a description and map of each GDE potentially or indirectly impacted by mining activities.

Issue

Section 8.1 outlines additional features within the Doongmabulla Spring complex. The location of these new features should be provided on a figure within the GDEMP.

Recommendation

Provide a map/figure that shows the location of the Home Springs, Bonanza Springs Group, Yukunna Kumoo Springs, Dusk Springs, Surprise Springs and the scalded areas around House Springs and Camps Springs where endemic *Trianthema sp.* The additional figure should be referred to in Section 8.1.

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Condition

The plan must include Detailed baseline monitoring (using QuickBird imagery or similar) to be undertaken on the specific ecology of each GDE, groundwater level, groundwater and surface water quality, threatened species and ecosystem function

Issue

There is inconsistencies between the table in Appendix – Groundwater drawdown and quality trigger – Early warning triggers and Table 43 – Groundwater Level Thresholds Summary.

There is inconsistencies in terminology when referring to groundwater level throughout the GDEMP. The indicator is referred to as 'depth to groundwater', for example on page 85.

Recommendation

Ensure consistency in terminology when referring to groundwater level.

Provide consistent groundwater level thresholds for all bores in both the GDEMP and GMMP.

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Condition

The plan must include Detailed baseline research to establish:

(a) the extent and ecological composition of each GDE, in accordance with the Wetland Monitoring Methodology for springs in the Great Artesian Basin (R. Fensham, 2009) where Applicable

Recommendation

No issue

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Condition

The plan must include detailed baseline research to establish the source aquifer(s) for groundwater supply to the GDE

Issue

1. The groundwater monitoring locations within the GDEMP for the Carmichael River are within the alluvium and Clematis Sandstone only. The Tertiary Sediments was identified in the GMMP as a source aquifer to the Carmichael River, therefore groundwater monitoring locations within the Tertiary Sediment should be included in Table 6-7.

In Table 7 – Groundwater Recharge and Discharge Mechanisms page 56 of GMMP - The Tertiary sediment's primary recharge mechanism is via vertical leakage from overlying alluvium and primary discharge mechanism is via vertical leakage to the overlying alluvium.

2. Section 8.3.6 discusses the properties of the Rewan Formation determined to date. However section 8.3.6 does not provide any detail of the baseline research that will be undertaken to evaluate the presence, extent and influence of various structure and stratigraphic characteristics of the Rewan Formation and how these may influence the behaviour of that unit with respect to allowing interconnection between overlying and underlying units.
3. Section 8.3.7 discusses the alternative model scenario where the source of the springs is below the Clematis. However, there is another alternative scenario, that should be discussed in this section, where there is hydraulic connectivity between the geological units below and above the Rewan Formation. This scenario can influence the modelled drawdown. To add confidence to the conceptual model and numerical model, additional work must be completed prior to the model review.
4. To provide greater certainty of contribution from additional aquifers to the GDEs, groundwater conceptual model and numerical model, additional work must be completed prior to the model re-run.

Recommendation

1. Provide groundwater monitoring locations within the Tertiary sediment in Table 6-7 Groundwater Monitoring Locations (from the GMMP) page 87 of GDEMP.
2. In section 8.3.6 provide a summary of the baseline research that will be undertaken to determine the presence, extent and influence of the various structure and stratigraphic characteristics of the Rewan Formation and how these influence the behaviour of the unit with respect to allowing interconnection between overlying and underlying units.
3. In section 8.3.7 discuss the potential alternative model scenario where there is hydraulic connectivity between the geological units below and above the Rewan Formation and the potential influence this scenario could have on the predicted drawdown.
4. To add confidence to the conceptual model and numerical model, additional work must be completed prior to the model review. It is recommended that Adani make the commitment to

undertake the following additional work prior to undertaking the Model Re-run as required by Condition E6:

- Hydrochemistry assessment of all bores from all aquifers, springs and the Carmichael River. This should include piper plots or similar analysis to determine source aquifers and interactions between hydrogeological units.
- Analysis of rock properties from the cores of new nested bores to inform hydraulic connectivity within and between hydrogeological units.
- At least 12 sampling units that are not more than 2 months apart over a 2 year period of water level and quality data from the new nested bores as per Condition E3(b).
- Determine the age of groundwater using isotopic tracers
- Use soon to be released GA airborne electromagnetic survey data to ascertain hydrogeology in and around the Groundwater Dependent Ecosystems. **This is subject to CSIRO/GA advice.**

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Condition

The plan must include detailed baseline research to establish the natural variation of the groundwater level/pressure

Issue

Section 8.8 refers to the installation of additional bores.

“The GMMP recommends the installation of additional bores, in order to evaluate the vertical gradients between hydrogeological units. These proposed additional monitoring bores will be completed in the Rewan Formation / Dunda Beds and will also be designated as early warning bores for vertical migration of potential drawdown from the deeper coal measures. They will be co-located, or within 500m of existing Clematis sandstone monitoring locations. (page 211-212)”

Recommendation

Further details regarding the location the new nested bores must be included in the GDEMP, as per the GMMP.

Provision of a commitment for the timeframe for installation and the location of the bores should be included, as per the GMMP. To determine the natural variation in groundwater level, at least 12 sampling events over a 2 year period, that are no more than 2 months apart, is required during the pre-impact period (as per Condition E3(b)).

Condition

The plan must include detailed baseline research to establish GDE ecosystem pressure response to groundwater level/pressure fluctuation

Recommendation

No issue

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Condition

The plan must include a description of how the results of baseline research and annual monitoring are to be used to determine any changes in GDE ecology attributable to mining activities

Issue

1. As the earliest predicted potential impacts are different for each GDE, the timeframes for the completion of pre-impact surveys is not clearly stated.

Table 6-2 for the Carmichael River threats, potential direct/indirect project impacts and matters required to be addressed by conditions and Table 7-3 – Waxy Cabbage Palm threats, potential direct/indirect project impacts and matters required to be addressed by conditions. Both tables show that surface water quality degradation and changes to surface water flows and flooding including water discharge are predicted to commence in year 1 of operation.

Table 8-5 Dooongmabulla Springs Complex threats, potential direct/indirect project impacts and matters required to be addressed by conditions it is noted that groundwater drawdown from mine dewatering earliest predicted potential impact is year 20 while changes to hydrology will occur from year 1.

Table 9-1 Mellaluka Springs complex – threats, potential direct/indirect project impacts and matters required to be addressed by conditions – it is noted 20 years until potential impacts from groundwater drawdown from mine dewatering and weed and pests through direct competition or habitat degradation.

Appendix C – Chart showing timing of key project element - For the Carmichael River and Waxy Cabbage Palm, both have impacts from clearing to occur in year 10 and groundwater drawdown from mine dewatering to commence impacts in Year 15.

2. Sections 8.7.2 (DSC) and 9.8.1 (Mellaluka Springs) refer to Ecological Condition reports that will be prepared on conclusion of the pre-impact surveys, however no timeframes are provided as to when these reports will be completed. **Section 8.7.3 states ‘Impact survey and monitoring will begin from excavation of the first box cut and afterwards for the life of the mine, and for at least five years after mining operations are completed.**
3. In section 5.5 – Ecological trigger levels. It is unclear how the Ecological triggers for each GDE in this section relate to the attributes listed in Table 5.1 or the indicators listed in each GDE sub plan.
4. Section 8.7.3 – Impact surveys and monitoring – this section does not include groundwater drawdown rates as an indicator.
5. Section 8.7.4 states - *Additional studies to determine the interaction with groundwater and the EWR of the springs and threatened flora species will occur as part of the research program that Adani has committed to.* No detail of what these studies will include is provided.
6. Section 8.7.4 states - *Groundwater modelling will be re-run as new information becomes available as per EA and EPBC Act approval conditions (within 2 years of commencement of mining activities and every 5 years thereafter).* Wording must be consistent with EA – within 2 years after excavation of first box cut.

Recommendation

1. It is important that the timeframes for the completion of the pre-impact surveys are consistent with timeframes of the predicted potential impacts as detailed in Appendix C and the timeframes are consistent in all the relevant sections of the GDEMP.

2. It is recommended that the reports on the pre-impact surveys for DSC is completed within 12 months of the excavation of first box cut so that the findings can be used to interpret the impact survey results.
3. Provide linkage and consistency when detailing monitoring surveys, monitoring attributes, indicators and parameters throughout the GDEMP.
4. Groundwater drawdown rate thresholds should be as an indicator in section 8.7.3 monitoring for DSC.
5. Provide a summary of the additional studies that Adani has committed to undertaking as part of the research program.
6. Ensure consistency of wording with EA requirements.

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Condition

The plan must include a description of the potential impact on each GDE from each project stage including impacts from subsidence, mine dewatering of aquifers, water discharge, hydrological changes and weed and pest infestation

Issue

1. The department understands that Adani has committed to install an additional 3 gauging stations, in addition to the two existing locations and further surveys to determine height-discharge relationships.

Section 6.6.1 Pre-impact monitoring, Table 6-8 Surface Water Monitoring Locations (from the REMP) and Figure 6-16 Surface Water Monitoring Locations (from the REMP) do not provide any details with respect to the 3 additional gauging stations.

2. In Section 6.3.5 it states '*Aquatic weeds were noted in additional assessments conducted further upstream at the Doongmabulla Springs-complex associated with the Joshua Springs-group*'. And in Section 8.1.3 Joshua Springs-group it states '*The Joshua Spring wetlands harbour a Category 3 restricted matter and WoNS Olive Hymenachne, with the outflow channel of the modified spring mound dam choked with this exotic grass.*'
3. In Section 8.6 – Mitigation and management measures on page 202 states '*Activities associated with aquifer drawdown are not expected to commence until approximately 2020, with the reduction in pressure of the aquifers expected after approximately 20 years (GHD 2014).*' Is this statement correct or does it need to be qualified to the Clematis aquifer? In Figure 25 of the GMMP shows drawdown occurring after 10 years in the Rewan Formation groundwater bore (C55P1).

Recommendation

1. It is recommended that Adani make a commitment in the GDMP to install stream gauges to adequately quantify impacts; i.e. One gauging station located where there is peak baseflow pre-impact, one in the area where drawdown prediction is greatest and one downstream where the disconnection in the surface water –groundwater move (25km to 15km downstream) within a stated timeframe.
2. The WoNS Olive Hymenachne warrants inclusion and particular focus for monitoring along the Carmichael River in *Table 6-10 Management objectives, performance criteria, adaptive management triggers and corrective actions for the Carmichael River - row # 7 Weeds and pest plants through direct competition or habitat degradation*. However, it should be noted that eradication at the source location of Joshua Spring outflow would prove to be a more cost-effective strategy.
3. Provide clarification with respect to when the predicted drawdown is to occur in the relevant aquifers associated with Doongmabulla Springs Complex.

Condition

The plan must include Mitigation measures to be undertaken to avoid, mitigate, offset and manage impacts to GDE environmental values resulting from each stage of the project

Issue

In Section 6.4 Threats and impacts (to the Carmichael River) under #1: Groundwater drawdown from mine dewatering in last paragraph on page 58 states *'These changes to groundwater flow will cause the base flow in the Carmichael River to be reduced to zero, via leakage to the ground in 'losing' sections of the river. This means that the isolated pools, which act as refugia for aquatic fauna during dry period, will become less frequent and will eventually dry out. These losing sections are predicted to migrate from 25km downstream of the eastern mining lease boundary pre-construction, to 15km downstream of the eastern mining lease boundary post development... The loss of isolated pools during dry periods could mean that fish and other aquatic fauna will be removed from the reach of stream impacted by aquifer dewatering.'*

In Table 6-10 Management objectives, performance criteria, adaptive management triggers and corrective actions for the Carmichael River with respect to #3 – Changes to surface water levels and flow there are omission that must be addressed to ensure adequate mitigation is achieved to potential impacts on the Carmichael River.

Recommendation

With respect # 3 row – Changes to surface water levels and flows re. The following changes are recommended:

Management actions – An adequate baseline surface flow, quality and level must be determined prior to impacts in the catchment. This includes a detailed understanding of the current losing-gaining nature along the length and response to seasonal variability to ensure goals relating to approved impacts can be assessed and be managed effectively.

Monitoring – Include 3 new gauging stations to adequately quantify impacts – one upstream where there is a peak in baseflow pre-impact, one in the area where groundwater drawdown is greatest and one downstream where the disconnection in surface water-groundwater moves (25km downstream to 15 downstream).

Corrective Action – Removal of grazing (watering by stock) in order to increase water pool life span from Year 20.

Consistency and implementation of the GDEMP

Advice has been provided on numerous occasions that there was a lack of consistency between sections and tables within the GDEMP.

At the Technical Workshop on Groundwater Management Plan (7/11/2018), the issue of consistency was discussed and the meeting notes state *“Regulators suggested Adani clearly link baseline data and pre-impact monitoring to the monitoring required for both performance criteria and triggers, and also that monitoring was described before the tables with performance criteria, etc.”*

Advice was provided on Version 10 with the main issues identified as -

- Conceptual model missing Joe Joe Group and Mellaluka Springs.
- The use of *interim* and *initial* trigger levels – it was decided at the meeting (7th Nov) that interim and initial would not be used?
- Consistency in how the groundwater level/drawdown triggers are referred to between sections.
- Consistency between the trigger values in Part 1 and the individual GDE sections is still missing. Also where trigger values are the same, for example between Carmichael River and Waxy Cabbage Palms.
- The Status and Description Section and the Summary of Baseline Monitoring Section could be combined in the individual GDE Sections.
- The Impact Monitoring and Triggers Sections need to be better separated or combined as there is a lot of repetition. For example, If separate Section 6.6.2 should better describe the methodology to monitor the indicators and Section 6.7 should outline the triggers and how they would be applied.
- Approach to statistical analysis table is missing in the Carmichael GDE section.
- The link between the indicators and statistical analysis table and the Management objectives table is needed in each GDE section.
- Groundwater quality trigger levels have not been included in the Appendices.

A revised version dated 20/11/2018 was reviewed with comments provided to Adani on 21/12/2018 which again identified that there was a lack of consistency between the statistical analysis and corrective action tables for each GDE. Specific comments on the surface and groundwater quantity and quality aspects of the tables was provided as an example of the level of consistency that was required throughout the GDEMP (not just when referring to surface and groundwater quality). This long standing issue is still to be addressed.

The issue of consistency within and between sections is important to meet the objectives of the GDEMP (page 1-2), in particular:

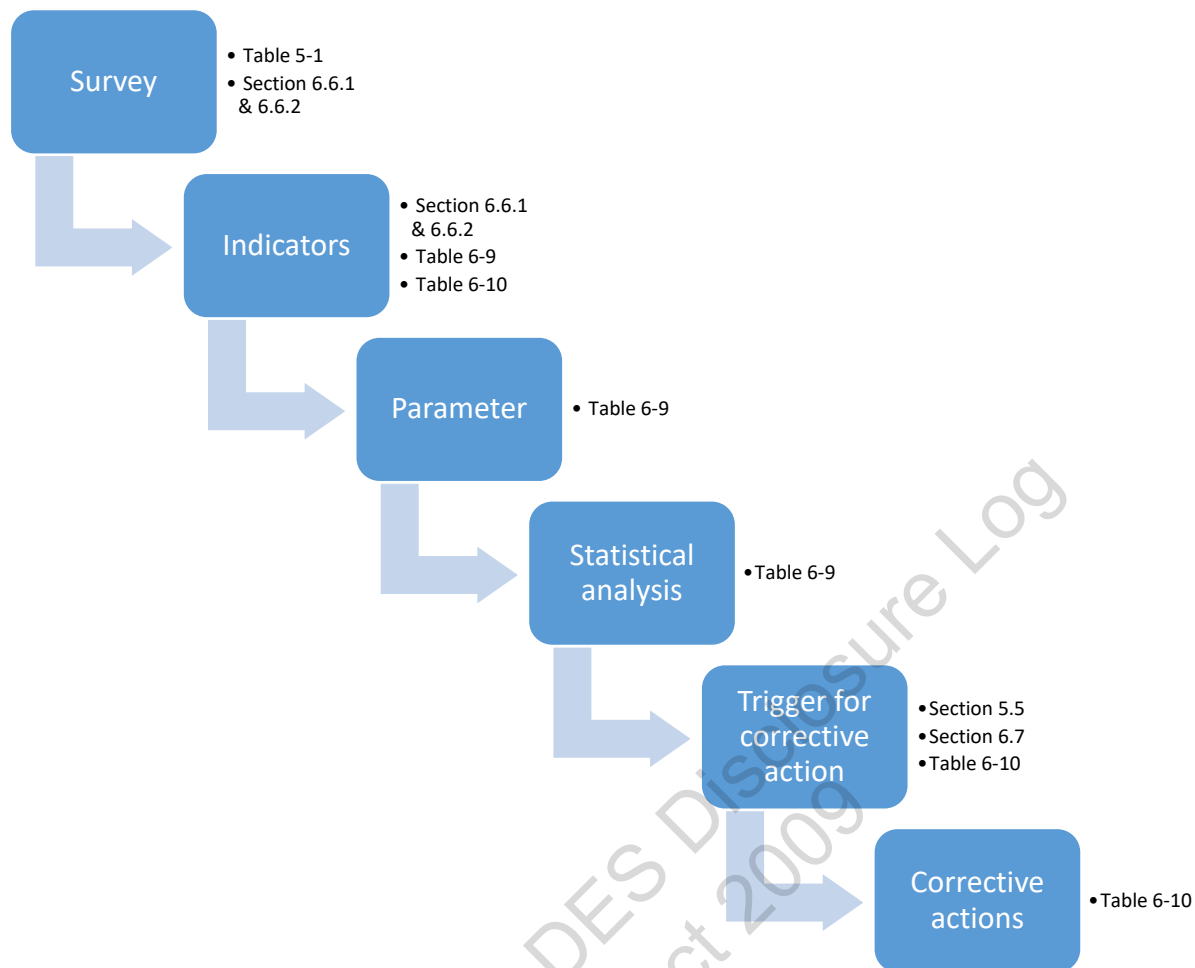
- Detail the monitoring program for both pre-impact and impact phases of the project, including how this monitoring will inform relevant mitigation, management and offset measures
- Describe mitigation and management measures with specific criteria, timing, performance objectives, goals and corrective measures.

It is stated on page 6 of the GDEMP that each management sub-plan in the GDEMP is structured to provide information in a consistent format on:

- Proposed monitoring program for the GDE across the pre-impact and impact stages
- Proposed triggers for both groundwater and ecological values of the GDE
- Details of mitigation and management measures to be implemented, including corrective actions.

Carmichael River sub plan is used as an example of the inconsistencies between Sections and Tables when referring to surveys, indicators, parameters and triggers. **A comparison Table at the end of this document has also been provided for Carmichael River and Doongmabulla springs.**

The linkage between the information provided in the GDEMP.



The ecological trigger levels that will be applied in the GDEMP are summarised in Section 5.5. However, this is not consistent with other sections within the report. The indicators that are listed in Section 6.6.1 and 6.6.2 for the Carmichael River are not the same as the indicators listed in Table 5-1 or Table 6-9. In addition, there are indicators in Table 6-10 which are not included in Section 6.6.1, 6.6.2 or Table 6-9. Ecological triggers in Table 6-10 should be provided for each indicator.

The indicators listed in Sections 6.6.1 and 6.6.2 are:

- Population structure
- Community condition
- Weeds and pests or weed cover and pests
- Riparian community health
- Fauna use of riparian habitat
- Canopy cover
- Wetland vegetation
- Threatened and endemic flora populations
- Spring wetland extent
- Groundwater level
- surface water level
- surface water flow
- Groundwater quality
- surface water quality
- presence of weed species
- extent of weed coverage
- presence of pest species
- extent of pest disturbance.

The list of indicators in Table 6-9 are:

- Riparian community health
- Fauna use of riparian habitat
- Weed and pests (within areas controlled by Adani)
- Groundwater Level
- Groundwater Quality
- Surface Water Flow (periods of flow)
- Surface Water Level (periods of no flow)
- Surface Water Quality.

The list of indicators in Table 6-10 are:

- | | |
|--|--|
| <ul style="list-style-type: none"> • Groundwater Level • Groundwater Quality • Surface Water Flow (periods of flow) • Surface Water Level (periods of no flow) • Surface Water Quality • Early warning signs of subsidence, such as tilt, strain and displacement exceeding predictions at monitoring locations. • Observations of cracking or ponding in the Carmichael River. • Visual record • pH • Turbidity • CORVEG attributes • Canopy cover • Visual evidence of disturbance or clearing • Ecological survey indicators • Area cleared • Population structure • Community condition | <ul style="list-style-type: none"> • Riparian community health • Fauna use of riparian habitat • Wetland vegetation • Threatened and endemic flora populations • Canopy cover • Rehabilitation success parameters as listed in Appendix 2 of the EA (native fauna species, plant regeneration, weed abundance, pest abundance), erosion • Fuel load levels and ground composition. • Presence of weed species • Extent of weed coverage • Presence of feral animals • Extent of damage from feral animals • Visual observation and records • Event monitoring for: dB(A) • peak particle velocity (PPV) • Event monitoring for: Total suspended particulate matter • Observations of amount of light falling on Carmichael River |
|--|--|

It may be that a number of indicators listed in Sections 6.6.1 and 6.6.2 are classed as parameters in Table 6-9. However, this is not the case for community condition or population structure. In addition, wetland vegetation, threatened and endemic flora populations and spring wetland extent are not listed in Table 6-9 but are included in Section 6.6.

In Section 6.6.1, the indicator of population structure is included in the riparian condition and aquatic ecology surveys. However, this indicator will measure different communities and this is not addressed in Table 6-9.

For example, early warning signs of subsidence and cracking and ponding in the Carmichael River are included as an indicator in Table 6-10 but not in the other sections. For indicators included in Table 6-10, that are not other sections above, it is important that the appropriate management plan be referred to in each case.

Threats and potential direct/indirect project impacts that are required to be addressed, as they apply to the Carmichael River, are identified Section 6.4 and listed below.

#	Potential Threat or Impact
1	Groundwater drawdown from mine dewatering
2	Subsidence from underground mining
3	Changes to surface water flows and flooding, including water discharge
4	Surface water quality degradation
5	Vegetation clearing and habitat loss, of approximately 5 hectares to build a bridge across the Carmichael River
6	Fire
7	Weeds and pest
8	Earthworks
9	Noise and vibration
10	Emissions (including dust)
11	Light spill and other visual impacts

Blank cells suggest information is missing. Red text suggests that consistency with terminology is required.

GDE	Monitoring survey	Table 5-1 - Monitoring attributes or methods	Section 5.5 – Ecological triggers	Indicators from Section 6.6.1 – pre impact	Indicators from Section 6.6.2 - impact	Table 6-9 - indicator	Table 6-9 - Parameter	Relevant Table 6-10 Number	Suggested relevant Table 6-10 number
Carmichael River	Ecological features map of the Carmichael River	Threatened and endemic flora locations	Change in the presence of native flora species recorded at monitoring sites located in the riparian zone of the Carmichael River from ecology surveys completed in Spring and Autumn 2011						#5
		Weed and pest locations		Weeds and pests					#7
		Riparian vegetation composition and health		Riparian community health Population structure Community composition (assumed equivalent)				#5	#1, #3, #4, #5
		Fauna use of riparian habitat		Fauna use of riparian habitat					#5
		Areas of connectivity or disconnection with groundwater							#1
		Gaining / losing areas relative to groundwater							#1
		Location of deep pools							#1, #3
		Location of riffles							#1, #3
		Location and size of aquatic macrophyte beds							#1, #3
		Other key aquatic habitat features							#1, #3
	Riparian condition surveys	CORVEG and/or BioCondition surveys	Reduction in riparian forest canopy cover as determined from analysis of aerial photography from period 2010 to 2018.	Riparian community health Population structure Community composition Canopy cover (assumed equivalent)	Riparian community health	Riparian community health	Structural formation, leaf litter cover, rock cover, bare ground, cryptogam cover, crown cover, species composition and cover (by species and by stratum), height of each strata, cover of coarse woody debris, number of	#5	#1, #3, #4, #5

GDE	Monitoring survey	Table 5-1 - Monitoring attributes or methods	Section 5.5 – Ecological triggers	Indicators from Section 6.6.1 – pre impact	Indicators from Section 6.6.2 - impact	Table 6-9 - indicator	Table 6-9 - Parameter	Relevant Table 6-10 Number	Suggested relevant Table 6-10 number
			Riparian community health indicators (CORVEG and BioCondition data) deviate from baseline and pre-impact conditions				large trees (eucalypt and non-eucalypt), diameter at breast height (DBH) of eucalypt and non- eucalypt trees, weed cover, erosion and severity, disturbances and severity, stem count for woody vegetation, basal area.		
				Weed cover and pests				#7	#7
				Fauna use of riparian habitat	Fauna use of riparian habitat	Fauna use of riparian habitat	Abundance of key species.		#5
				Wetland vegetation (unclear why this is included here)					Delete
				Groundwater level (described in text, but not included in list for pre-impact but included in impact)	Groundwater level				#1
	Aquatic Ecological Surveys	Vertebrate species presence, in particular at remnant pools		Population structure (assumed equivalent)					#1, #3, #4, #5
		Ecological condition (e.g. using AusRivAS)	Macro-invertebrate sampling using AusRivAS methods - EPT (Ephemeroptera, Plecoptera and Trichoptera) ratios of macroinvertebrates fall below baseline values of 6.7% (Autumn) and 15.8% (Spring)	Community condition (assumed equivalent)					#1, #3, #4, #5
		Ecological patterns (macrophytes, fish, invertebrates)		Population structure (assumed equivalent)					#1, #3, #4, #5
				Weeds and pests					#7
				Riparian community health					Delete

GDE	Monitoring survey	Table 5-1 - Monitoring attributes or methods	Section 5.5 – Ecological triggers	Indicators from Section 6.6.1 – pre impact	Indicators from Section 6.6.2 - impact	Table 6-9 - indicator	Table 6-9 - Parameter	Relevant Table 6-10 Number	Suggested relevant Table 6-10 number
				(unclear why included in this survey)					
				Fauna use of riparian habitat (unclear why included in this survey)					Delete
				Spring wetland extent (unclear why included in this survey)					Delete
				Wetland vegetation (unclear why included in this survey)					Delete
		Ecological patterns (macrophytes, fish, invertebrates)		Threatened and endemic flora locations (macrophytes)?					?
	Groundwater monitoring	Groundwater level and quality		Groundwater level	Groundwater level	Groundwater level	Groundwater level	#1	#1
				Groundwater quality	Groundwater quality	Groundwater quality	Water quality parameters as outlined in GMMP.	#1, #4	#1, #4
					Groundwater drawdown rate should be included as an indicator				#1
	Surface water monitoring	Surface water level, flow and quality		Surface water level	Surface water level	Surface Water Level (periods of no flow)	Surface Water Level (periods of no flow)	#1, #3	#1, #3
				Surface water flow	Surface water flow	Surface Water Flow (periods of flow)	River discharge	#1, #3	#1, #3
				Surface water quality	Surface water quality	Surface water quality	Water quality parameters as outlined in REMP.	#1, #3, #4	#1, #3, #4
	Weed and pest surveys	Presence of weed species and extent of coverage	Weed species recorded at riparian monitoring sites on the Carmichael River that did not have that weed species recorded during	presence of weed species	presence of weed species	Weed and pests (within areas controlled by Adani)	Inventory of all weed and pest species present. Identify spatial extent of weeds, especially Rubber Vine, along the	#7	#7

GDE	Monitoring survey	Table 5-1 - Monitoring attributes or methods	Section 5.5 – Ecological triggers	Indicators from Section 6.6.1 – pre impact	Indicators from Section 6.6.2 - impact	Table 6-9 - indicator	Table 6-9 - Parameter	Relevant Table 6-10 Number	Suggested relevant Table 6-10 number
			ecology surveys completed in Spring and Autumn 2011.				Carmichael River. Identify areas of Riparian habitat subject to pig damage. (this should be more than just pig damage)		
			Identification of new weed or pest species at any location along the riparian zone of the Carmichael River						
		Presence of pest species and extent of disturbance	New population or area affected by weed or pests	extent of weed coverage	extent of weed coverage			#7	#7
			Identification of new weed or pest species at any location along the riparian zone of the Carmichael River.	presence of pest species	presence of pest species			#7	#7
			New population or area affected by weed or pests	extent of pest disturbance	extent of pest disturbance			#7	#7

GDE	Monitoring survey	Table 5-1 - Monitoring attributes or methods	Section 5.5 – Ecological triggers	Indicators from Section 8.7.1 – pre impact	Indicators from Section 8.7.3 - impact	Table 8-9 - indicator	Table 8-9 - Parameter	Relevant Table 8-10 Number	Suggested relevant Table 8-10 number
Doongmabulla Spring complex	Spring Monitoring	Spring-head pressure							1
		Flow rate (if measureable)		Flow rate (surface water monitoring)	Spring flow				1
	Mound Springs data	Mound springs diameter, height and perimeter	Deviation from baseline conditions of mound springs characteristics (maximum diameter, height, perimeter length, full floristics species composition)	Mound springs – no indicators specified					1

GDE	Monitoring survey	Table 5-1 - Monitoring attributes or methods	Section 5.5 – Ecological triggers	Indicators from Section 8.7.1 – pre impact	Indicators from Section 8.7.3 - impact	Table 8-9 - indicator	Table 8-9 - Parameter	Relevant Table 8-10 Number	Suggested relevant Table 8-10 number
			and abundance, abundance of spring endemic flora species, abundance of threatened species)						
		Full floristic species composition and abundances	Deviation from baseline conditions of mound springs characteristics	Mound springs – no indicators specified					1, 6
		Population surveys for spring endemic flora species	Absence of GAB spring endemic species observed in Moses Spring in 2012 and 2013 baseline surveys	Mound springs – no indicators specified					1, 6
		Population surveys for Commonwealth and State listed species	Deviation from baseline conditions of mound springs characteristics	Mound springs – no indicators specified					1, 6
		Photographic references (photo point monitoring)		Mound springs – no indicators specified					1
	Wetland vegetation monitoring	Identify wetland zones and their boundary locations	Reduction in wetland area as determined from analysis of aerial photography from period 2010 to 2018.	Spring wetland extent (habitat features survey) (assumed equivalent)			Perennial wetland cover assessed both on site and via remote sensing.	5	1
		Photographic references (photo point monitoring)					Photographic reference		1
		Wetland vegetation species composition	Deviation from baseline conditions of wetland vegetation characteristics (area of wetland zones, vegetation species composition and vegetation species abundance)	wetland vegetation zone native vegetation cover (assumed equivalent)		Wetland vegetation species composition	Identify wetland zones (pool, saturated, damp, dry) and their boundary locations. Wetland vegetation species composition	1, 6	

GDE	Monitoring survey	Table 5-1 - Monitoring attributes or methods	Section 5.5 – Ecological triggers	Indicators from Section 8.7.1 – pre impact	Indicators from Section 8.7.3 - impact	Table 8-9 - indicator	Table 8-9 - Parameter	Relevant Table 8-10 Number	Suggested relevant Table 8-10 number
		Wetland vegetation species abundances	Deviation from baseline conditions of wetland vegetation characteristics (area of wetland zones, vegetation species composition and vegetation species abundance)			Wetland vegetation species abundances	Wetland vegetation Species abundances (1 m x 1 m subplots spaced 4 m apart, along the transect)		1, 6
	Threatened and endemic flora populations	Targeted surveys for threatened and endemic flora populations at each spring head in the Moses Springs-group and each springs wetland	Deviation from baseline conditions in the number and abundance of threatened and endemic flora species	Threatened and endemic species presence, condition and location	Threatened and endemic species presence, condition and location	Threatened and endemic flora populations	Location, extent and condition of <ul style="list-style-type: none"> • Waxy Cabbage Palm <i>Livistona lanuginosa</i> (Vulnerable – Moses) • Blue Devil <i>Eryngium fontanum</i> (Endangered - Moses) • Salt pipewort <i>Eriocaulon carsonii</i> subsp. <i>Orientalis</i> (Endangered – Moses) • <i>Hydrocotyle dippleura</i> (Vulnerable - Moses) • <i>Isotoma</i> sp. 'RJ Fensham 3883' (Endemic – Moses) • <i>Myriophyllum artesium</i> (Endangered – Moses and Joshua) • <i>Sporobolus pamela</i> (Endangered – Moses) • <i>Sporobolus partimpatens</i> (Near Threatened – Moses and Joshua) • Any other flora identified during baseline surveys as endemic or threatened, and reliant on GAB spring wetlands for survival. 	1, 6	

GDE	Monitoring survey	Table 5-1 - Monitoring attributes or methods	Section 5.5 – Ecological triggers	Indicators from Section 8.7.1 – pre impact	Indicators from Section 8.7.3 - impact	Table 8-9 - indicator	Table 8-9 - Parameter	Relevant Table 8-10 Number	Suggested relevant Table 8-10 number
	Aquatic invertebrate communities	Characterisation of aquatic macroinvertebrate communities	Deviation from baseline conditions of aquatic invertebrate communities (utilising AusRivAS protocols).						1
		Macroinvertebrate genera and species richness		Macroinvertebrate genera and species richness				1	
	Stygofauna	Stygofauna presence and endemism		Stygofauna presence, stygofauna endemism				1	
	Groundwater monitoring	Groundwater level and quality		Groundwater level	Groundwater level	Groundwater level	Groundwater level	1	
				Groundwater quality	Groundwater quality	Groundwater quality	Water quality parameters as outlined in GMMP.	1	
					Groundwater drawdown rate should be included as an indicator				1
	Surface water monitoring	Spring wetland extent and water level	Deviation from baseline Spring wetland extent	Spring wetland extent (habitat features survey) (assumed equivalent)	Wetland extent (assumed equivalent)	Spring wetland extent	Perennial wetland cover assessed both on site and via remote sensing. Identify wetland zones (pool, saturated, damp, dry) and their boundary locations. Photographic reference	1	
				Spring wetland water level Wetland pool depth	Wetland level (assumed equivalent)			1	
		Surface water quality		Surface water quality	Surface water quality			2, 7	
				Flow rates				2	
	Weed and pest surveys	Presence of weed species and extent of coverage	Weed species recorded at riparian monitoring sites on the Carmichael River that did not have that weed species recorded during ecology surveys	presence of weed species	presence of weed species			4	

GDE	Monitoring survey	Table 5-1 - Monitoring attributes or methods	Section 5.5 – Ecological triggers	Indicators from Section 8.7.1 – pre impact	Indicators from Section 8.7.3 - impact	Table 8-9 - indicator	Table 8-9 - Parameter	Relevant Table 8-10 Number	Suggested relevant Table 8-10 number
			completed in Spring and Autumn 2011. Identification of new weed or pest species at any location along the riparian zone of the Carmichael River						
			New population or area affected by weed or pests	extent of weed coverage	extent of weed coverage			4	
		Presence of pest species and extent of disturbance	New population or area affected by weed or pests Identification of new weed or pest species at any location along the riparian zone of the Carmichael River.	presence of pest species	presence of pest species			4	
			New population or area affected by weed or pests	extent of pest disturbance	extent of pest disturbance			4	

Date : 30/05/2019 2:40:26 PM

From : "MCCOSKER Juliana"

To : "CLAUS Sonia"

Subject : re. GDEMP comments

Attachment : Departmental Comments on the GDEMP version 11b.docx;image001.png;image002.png;

Hi Sonia,

Can you please review and make sure I have not missed anything critical.

Ciao for now

Juliana



Juliana McCosker

Manager

Business Centre Coal - Coal and Central Queensland Compliance

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Departmental Comments on the GDEMP version 11b

Environmental Authority Holder: Adani Mining Pty Ltd

EA: EPML01470512

Project: Carmichael Coal Mine

Document: Groundwater Dependent Ecosystem Management Plan

EA Conditions: I11 to I14 and definition requirements in Appendix 1

Document Full Title	Groundwater Dependent Ecosystem Management Plan – Carmichael Coal Project submitted 9 April 2019
Delegate	Juliana McCosker
Reviewing Officer	Kate Bennink
Receiving Date	9 April 2019
Background information	<p>This review was completed on the GDEMP version 11b submitted on 9 April 2019</p> <p>In completing this review, consideration was given to the following:</p> <ul style="list-style-type: none">• The GDEMP version 11b received on 9 April 2019. GDEMP Track changes v10 to 11 and GDEMP track changes v11a to v11b.• Independent scientific review Advice from CSIRO and GA received on 9 April 2019. <i>'Advice on Groundwater Management and Monitoring and Groundwater Dependent Ecosystem Management plans to the Department of the Environment and Energy. February 2019.'</i>• Independent scientific review Advice from CSIRO and Geoscience Australia received on 20 November 2018. <i>'Carmichael Coal Mine - Advice on draft research plans to the Department of the Environment and Energy November 2018'.</i>• Summary of that advice and Adani's response prepared by the Department of the Environment and Energy received on 9 April 2019 entitled <i>'Summary of CSIRO and Geoscience Australia Advice on Groundwater Management Plans and Response'.</i>• 16 April 2019, Briefing by CSIRO, GA and DOEE regarding their advice, Adani's response and revisions of groundwater management plans.• Technical advice from DES Water Sciences.

Condition

I11 The proponent must develop and implement a Groundwater Dependent Ecosystems Management Plan (GDEMP) to detail the management of threats to defined environmental values and to report results and corrective actions for each GDE over the full period of mining activities and for a period of five years post mining rehabilitation.

Issue

There are numerous inconsistencies between Sections and Tables when referring to surveys, indicators, parameters and triggers. See detailed examples below.

Due to the inconsistencies throughout the GDEMP, it is recommended that a summary of all the surveys and indicators/parameters that will be monitored for each GDE as part of the GDEMP be included in the GDEMP. This is to ensure that all appropriate data is collected and not overlooked. A revision of the GDEMP should also be done to improve the consistency between and within sections and tables.

It is acknowledged that the triggers and corrective actions may need to be revised after monitoring commences. A commitment to update the GDEMP with proposed triggers for all indicators/parameters after 12 months should be included in the GDEMP.

Recommendation

It is recommended that a revision of the GDEMP is undertaken that ensures consistency between and within sections and tables. This revision should include a summary of all the surveys and indicators/parameters within each GDE section.

Condition

I12 The GDEMP must be approved by the administering authority in writing and the GDEMP published on a website before the commencement of Project Stage 2.

Issue**Recommendation**

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Condition

I13 For the purposes of conditions I11 and I12, the GDEs include the affected Carmichael River riparian zone (ecosystems associated with the Carmichael River between Doongmabulla Springs and the Belyando River, including populations of Waxy Cabbage Palm), the Lignum, Stories and Mellaluka springs and the Doongmabulla, Spring complex.

Issue

The GDEMP clearly addresses the GDEs as required by Condition I13

Recommendation

No issue

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Condition

I14 report of the findings of the GDEMP, including all monitoring results and interpretations, must be prepared annually and made available on request to the administering authority. The report must include:

- a) an assessment of background reference groundwater levels (see condition E9)
- b) the condition of each GDE compared with previous monitoring results
- c) the suitability of current groundwater trigger thresholds (as defined in condition E13)
- d) detail on the effectiveness of avoidance, mitigation and management actions in curtailing adverse impacts on GDE ecosystems
- e) a description of any adaptive management initiatives implemented
- f) any offsets required for residual impacts

Issue

Due to the inconsistency and lack of trigger values and corrective actions for all indicators in the GDEMP, it will be difficult to report on the condition of each GDE compared with previous monitoring results. It will also be difficult to detail the effectiveness of avoidance, mitigation and management actions in curtailing adverse impacts on GDE ecosystems or any adaptive management initiatives implemented.

Recommendation

DES recommends the GDEMP is updated to include propose triggers for all indicators/parameters and improve the consistency between and within sections and tables be done as discussed above.

It is acknowledged that the triggers and corrective actions may need to be revised after monitoring commences. A commitment to update the GDEMP with proposed triggers for all indicators/parameters after 12 months should be included in the GDEMP.

Definition requirements

A GDEMP is a plan developed by a suitably qualified and experienced person that is consistent with any Bioregional Management Plan for the bioregion, the Water Resource (Great Artesian Basin) Plan and relevant threat abatement plans, conservation advice and project species management plans.

Issue

Lack of consistency with Waxy Cabbage Palm conservation advice

<http://www.environment.gov.au/biodiversity/threatened/species/pubs/64581-conservation-advice.pdf>

The conservation advice states - Prevent grazing pressure at known sites on leased crown land through exclusion fencing or other barriers.

Recommendation

It is recommended that as a corrective action - grazing is removed from the Carmichael River to prevent trampling and reduction of water supply to waxy cabbage palm populations and ensure consistency with the Conservation Advice.

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Condition

The plan must include a description and map of each GDE potentially or indirectly impacted by mining activities

Issue

Section 8.1 outlines additional features within the Doongmabulla Spring complex. The location of these new features should be provided on a figure within the GDEMP.

Recommendation

Provide a map/figure that shows the location of the Home Springs, Bonanza Springs Group, Yukunna Kumoo Springs, Dusk Springs, Surprise Springs and the scalded areas around House Springs and Camps Springs where endemic *Trianthema sp.* The additional figure should be referred to in Section 8.1.

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Condition

The plan must include Detailed baseline monitoring (using QuickBird imagery or similar) to be undertaken on the specific ecology of each GDE, groundwater level, groundwater and surface water quality, threatened species and ecosystem function

Issue

Ensure consistency of terminology – groundwater level is the indicator and should not be referred to as 'depth to groundwater' as on page 85.

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Condition

The plan must include Detailed baseline research to establish:

- (a) the extent and ecological composition of each GDE, in accordance with the Wetland Monitoring Methodology for springs in the Great Artesian Basin (R. Fensham, 2009) where Applicable

No Issue

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Condition

The plan must include detailed baseline research to establish the source aquifer(s) for groundwater supply to the GDE

Issue

1. The groundwater monitoring locations within the GDEMP for the Carmichael River are within the alluvium and Clematis Sandstone only. The Tertiary Sediments was identified in the GMMP as a source aquifer to the Carmichael River, therefore groundwater monitoring locations within the Tertiary Sediment should be included in Table 6-7.

In Table 7 – Groundwater Recharge and Discharge Mechanisms page 56 of GMMP - The Tertiary sediment's primary recharge mechanism is via vertical leakage from overlying alluvium and primary discharge mechanism is via vertical leakage to the overlying alluvium.

2. Section 8.3.6 discusses the properties of the Rewan Formation determined to date. However section 8.3.6 does not provide any detail of the baseline research that will be undertaken to evaluate the presence, extent and influence of various structure and stratigraphic characteristics of the Rewan Formation and how these may influence the behaviour of that unit with respect to allowing interconnection between overlying and underlying units.
3. Section 8.3.7 discusses the alternative model scenario where the source of the springs is below the Clematis. However, there is another alternative scenario, that should be discussed in this section, where there is hydraulic connectivity between the geological units below and above the Rewan. This scenario can influence the modelled drawdown. To add confidence to the conceptual model and numerical model, additional work must be completed prior to the model review.
4. To provide greater certainty to the groundwater conceptual model and numerical model, additional work must be completed prior to the model re-run.

Recommendation

1. Provide groundwater monitoring locations within the Tertiary sediment in Table 6-7 Groundwater Monitoring Locations (from the GMMP) page 87 of GDEMP.
2. In section 8.3.6 provide a summary of the baseline research that will be undertaken to determine the presence, extent and influence of the various structure and stratigraphic characteristics of the Rewan Formation and how these influence the behaviour of the unit with respect to allowing interconnection between overlying and underlying units.
3. To add confidence to the conceptual model and numerical model, additional work must be completed prior to the model review. It is recommended that Adani make the commitment to undertake the following additional work prior to undertaking the Model Re-run as required by Condition E6:

- Hydrochemistry assessment of all bores from all aquifers, springs and the Carmichael River. This should include piper plots or similar analysis to determine source aquifers and interactions between hydrogeological units.
 - Analysis of rock properties from the cores of new nested bores to inform hydraulic connectivity within and between hydrogeological units.
 - At least 12 sampling units that are not more than 2 months apart over a 2 year period of water level and quality data from the new nested bores as per Condition E3(b).
 - Determine the age of groundwater using isotopic tracers
 - Use soon to be released GA airborne electromagnetic survey data to ascertain hydrogeology in and around the Groundwater Dependent Ecosystems.
4. It is recommended that Adani make a commitment to completing the following additional work prior to undertaking the Model re-run as required by Condition E6:
- Hydrochemistry assessment of all bores from all aquifers, springs and the Carmichael River. This should include piper plots or similar analysis to determine source aquifers and interactions between hydrogeological units.
 - Analysis of rock properties from the cores of new nested bores to inform hydraulic connectivity within and between hydrogeological units.
 - At least 12 sampling units that are not more than 2 months apart over a 2 year period of water level and quality data from the new nested bores as per Condition E3(b).
 - Determine the age of groundwater using isotopic tracers
 - Use soon to be released GA airborne electromagnetic survey data to ascertain hydrogeology in and around the Groundwater Dependent Ecosystems.

Condition

The plan must include detailed baseline research to establish the natural variation of the groundwater level/pressure

Issue

Section 8.8 refers to the installation of additional bores.

“The GMMP recommends the installation of additional bores, in order to evaluate the vertical gradients between hydrogeological units. These proposed additional monitoring bores will be completed in the Rewan Formation / Dunda Beds and will also be designated as early warning bores for vertical migration of potential drawdown from the deeper coal measures. They will be co-located, or within 500m of existing Clematis sandstone monitoring locations. (page 211-212)”

Recommendation

Further details regarding the location the new nested bores must also be included in the GDEMP.

Provision of a commitment for the timeframe for installation and the location of the bores should be included, as per the GMMP. To determine the natural variation in groundwater level, at least 12 sampling events over a 2 year period, that are no more than 2 months apart, is required during the pre-impact period.

Condition

The plan must include detailed baseline research to establish GDE ecosystem pressure response to groundwater level/pressure fluctuation

No Issue

Published on DES Disclosure Log
RTI Act 2009

Condition

The plan must include a description of how the results of baseline research and annual monitoring are to be used to determine any changes in GDE ecology attributable to mining activities

Issue

1. As the earliest predicted potential impacts are different for each GDE, the timeframes for the completion of pre-impact surveys is not clearly stated.

Table 6-2 for the Carmichael River threats, potential direct/indirect project impacts and matters required to be addressed by conditions and **Table 7-3 – Waxy Cabbage Palm threats, potential direct/indirect project impacts and matters required to be addressed by conditions**. Both tables show that surface water quality degradation and changes to surface water flows and flooding including water discharge are predicted to commence in year 1 of operation.

Table 8-5 Dooongmabulla Springs Complex threats, potential direct/indirect project impacts and matters required to be addressed by conditions it is noted that groundwater drawdown from mine dewatering earliest predicted potential impact is year 20 while changes to hydrology will occur from year 1.

Table 9-1 Mellaluka Springs complex – threats, potential direct/indirect project impacts and matters required to be addressed by conditions – it is noted 20 years until potential impacts from groundwater drawdown from mine dewatering and weed and pests through direct competition or habitat degradation. **Appendix C – Chart showing timing of key project element** For the Carmichael River and Waxy Cabbage Palm, both have impacts from clearing to occur in year 10 and groundwater drawdown from mine dewatering to commence impacts in Year 15.

2. Sections 8.7.2 (DSC) and 9.8.1 (Mellaluka Springs) refer to Ecological Condition reports that will be prepared on conclusion of the pre-impact surveys, however no timeframes are provided as to when these reports will be completed. **Section 8.7.3 states ‘Impact survey and monitoring will begin from excavation of the first box cut and afterwards for the life of the mine, and for at least five years after mining operations are completed.**
3. In section 5.5 – Ecological trigger levels. It is unclear how the Ecological triggers for each GDE in this section relate to the attributes listed in Table 5.1 or the indicators listed in each GDE sub plan.
4. Section 8.7.3 – Impact surveys and monitoring – this section does not include groundwater drawdown rates as an indicator.
5. Section 8.7.4 states - *Additional studies to determine the interaction with groundwater and the EWR of the springs and threatened flora species will occur as part of the research program that Adani has committed to. No detail of what these studies will include is provided.*
6. Section 8.7.4 states - *Groundwater modelling will be re-run as new information becomes available as per EA and EPBC Act approval conditions (within 2 years of commencement of mining activities and every 5 years thereafter). Wording must be consistent with EA – within 2 years after excavation of first box cut.*

Recommendation

1. It is important that the timeframes for the completion of the pre-impact surveys are consistent with timeframes of the predicted potential impacts as detailed in Appendix C and the timeframes are consistent in all the relevant sections of the GDEMP.

2. It is recommended that the reports on the pre-impact surveys for DSC is completed within 12 months of the excavation of first box cut so that the findings can be used to interpret the impact survey results.
3. Provide linkage and consistency when detailing monitoring surveys, monitoring attributes, indicators and parameters throughout the GDEMP.
4. Groundwater drawdown rate thresholds should be as an indicator in section 8.7.3 monitoring for DSC.
5. Provide a summary of the additional studies that Adani has committed to undertaking as part of the research program.
6. Ensure consistency of wording with EA requirements.

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Condition

The plan must include a description of the potential impact on each GDE from each project stage including impacts from subsidence, mine dewatering of aquifers, water discharge, hydrological changes and weed and pest infestation

Issue

1. The department understands that Adani has committed to install an additional 3 gauging stations, in addition to the two existing locations and further surveys to determine height-discharge relationships.

Section 6.6.1 Pre-impact monitoring, Table 6-8 Surface Water Monitoring Locations (from the REMP) and Figure 6-16 Surface Water Monitoring Locations (from the REMP) do not provide any details with respect to the 3 additional gauging stations.

2. In Section 6.3.5 it states '*Aquatic weeds were noted in additional assessments conducted further upstream at the Doongmabulla Springs-complex associated with the Joshua Springs-group*'. And in Section 8.1.3 Joshua Springs-group is states '*The Joshua Spring wetlands harbour a Category 3 restricted matter and WoNS Olive Hymenachne, with the outflow channel of the modified spring mound dam choked with this exotic grass.*'
3. In Section 8.6 – Mitigation and management measures on page 202 states '*Activities associated with aquifer drawdown are not expected to commence until approximately 2020, with the reduction in pressure of the aquifers expected after approximately 20 years (GHD 2014).*' Is this statement correct or does it need to be qualified to the Clematis aquifer? In Figure 25 of the GMMP shows drawdown occurring after 10 years in the Rewan groundwater bore (C55P1).

Recommendation

1. It is recommended that Adani make a commitment in the GDMP to install stream gauges to adequately quantify impacts; i.e. One gauging station located where there is peak baseflow pre-impact, one in the area where drawdown prediction is greatest and one downstream where the disconnection in the surface water –groundwater move (25km to 15km downstream) within a stated timeframe.
2. The WoNS Olive Hymenachne warrants inclusion and particular focus for monitoring along the Carmichael River in *Table 6-10 Management objectives, performance criteria, adaptive management triggers and corrective actions for the Carmichael River - row # 7 Weeds and pest plants through direct competition or habitat degradation*. However, it should be noted that eradication at the source location of Joshua Spring outflow would prove to be a more cost-effective strategy).
3. Provide clarification with respect to when the predicted drawdown is to occur in the relevant aquifers associated with Doongmabulla Springs Complex.

Condition

The plan must include Mitigation measures to be undertaken to avoid, mitigate, offset and manage impacts to GDE environmental values resulting from each stage of the project

Issue

In Section 6.4 Threats and impacts (to the Carmichael River) under #1: Groundwater drawdown from mine dewatering in last paragraph on page 58 states *'These changes to groundwater flow will cause the base flow in the Carmichael River to be reduced to zero, via leakage to the ground in 'losing' sections of the river. This means that the isolated pools, which act as refugia for aquatic fauna during dry period, will become less frequent and will eventually dry out. These losing sections are predicted to migrate from 25km downstream of the eastern mining lease boundary pre-construction, to 15km downstream of the eastern mining lease boundary post development... The loss of isolated pools during dry periods could mean that fish and other aquatic fauna will be removed from the reach of stream impacted by aquifer dewatering.'*

In Table 6-10 Management objectives, performance criteria, adaptive management triggers and corrective actions for the Carmichael River with respect to #3 – Changes to surface water levels and flow there are omission that must be addressed to ensure adequate mitigation is achieved to potential impacts on the Carmichael River.

Recommendation

With respect # 3 row – Changes to surface water levels and flows re. The following changes are recommended:

Management actions – An adequate baseline surface flow, quality and level must be determined prior to impacts in the catchment. This includes a detailed understanding of the current losing-gaining nature along the length and response to seasonal variability to ensure goals relating to approved impacts can be assessed and be managed effectively.

Monitoring – Include 3 new gauging stations to adequately quantify impacts – one upstream where there is a peak in baseflow pre-impact, one in the area where groundwater drawdown is greatest and one downstream where the disconnection in surface water-groundwater moves (25km downstream to 15 downstream).

Corrective Action – Removal of grazing (watering by stock) in order to increase water pool life span from Year 20.

Consistency and implementation of the GDEMP

Advice has been provided previously on numerous occasions that there was a lack of consistency between sections and tables within the GDEMP.

At the Technical Workshop on Groundwater Management Plan (7/11/2018), the issue of consistency was discussed and the meeting notes state *“Regulators suggested Adani clearly link baseline data and pre-impact monitoring to the monitoring required for both performance criteria and triggers, and also that monitoring was described before the tables with performance criteria, etc.”*

Advice was provided on Version 10 - main issues identified were -

- Conceptual model missing Joe Joe Group and Mellaluka Springs.
- The use of *interim* and *initial* trigger levels – it was decided at the meeting (7th Nov) that interim and initial would not be used?
- Consistency in how the groundwater level/drawdown triggers are referred to between sections.
- Consistency between the trigger values in Part 1 and the individual GDE sections is still missing. Also where trigger values are the same, for example between Carmichael River and Waxy Cabbage Palms.
- The Status and Description Section and the Summary of Baseline Monitoring Section could be combined in the individual GDE Sections.
- The Impact Monitoring and Triggers Sections need to be better separated or combined as there is a lot of repetition. For example, If separate Section 6.6.2 should better describe the methodology to monitor the indicators and Section 6.7 should outline the triggers and how they would be applied.
- Approach to statistical analysis table is missing in the Carmichael GDE section.
- The link between the indicators and statistical analysis table and the Management objectives table is needed in each GDE section.
- Groundwater quality trigger levels have not been included in the Appendices.

A revised version dated 20/11/2018 was reviewed with comments provided to Adani on 21/12/2018 which again identified that there was a lack of consistency between the statistical analysis and corrective action tables for each GDE. Specific comments on the surface and groundwater quantity and quality aspects of the tables was provided as an example of the level of consistency that was required throughout the GDEMP (not just when referring to surface and groundwater quality). This long standing issue is still to be addressed.

The issue of consistency within and between sections is important to meet the objectives of the GDEMP (page 1-2), in particular:

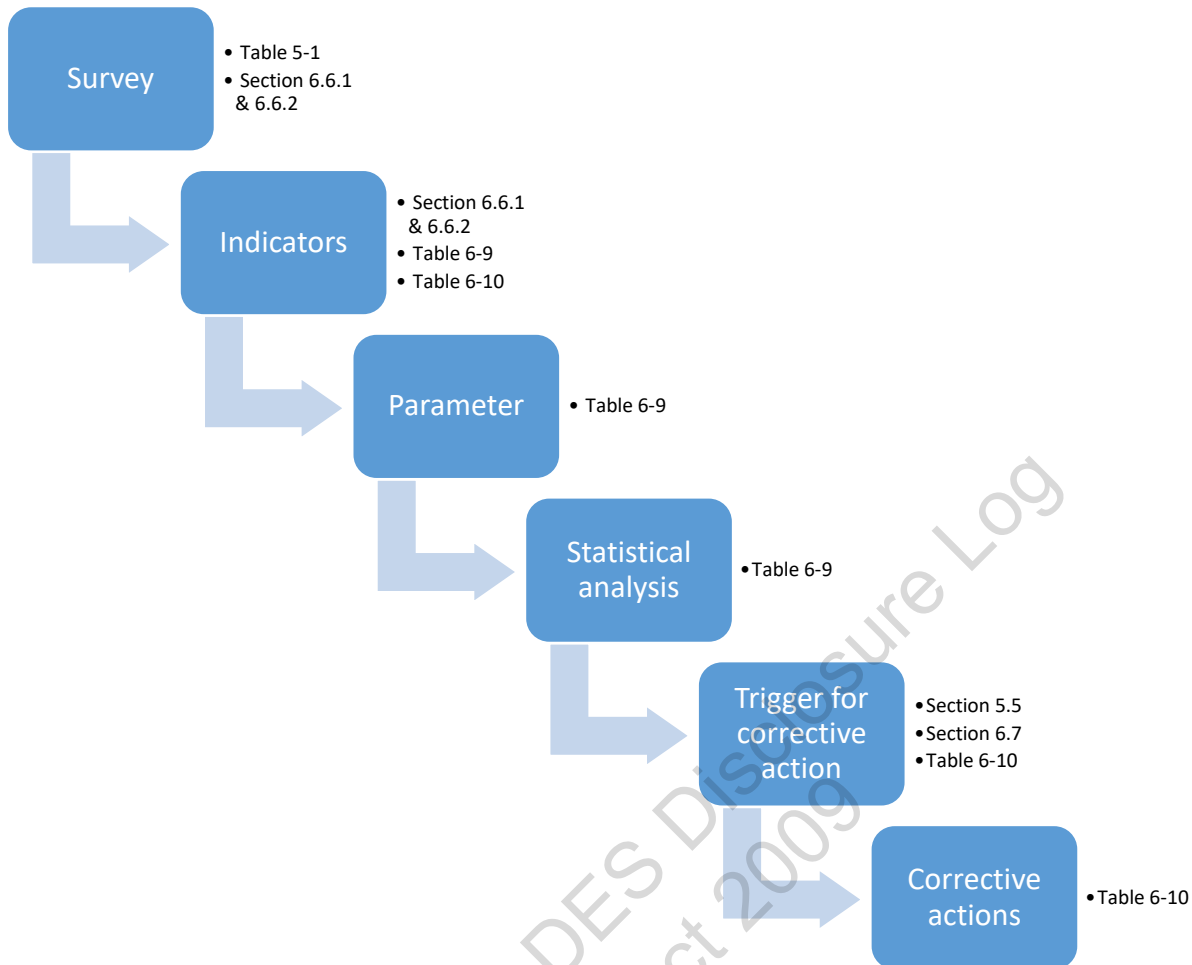
- Detail the monitoring program for both pre-impact and impact phases of the project, including how this monitoring will inform relevant mitigation, management and offset measures
- Describe mitigation and management measures with specific criteria, timing, performance objectives, goals and corrective measures.

It is stated on page 6 of the GDEMP that each management sub-plan in the GDEMP is structured to provide information in a consistent format on:

- Proposed monitoring program for the GDE across the pre-impact and impact stages
- Proposed triggers for both groundwater and ecological values of the GDE
- Details of mitigation and management measures to be implemented, including corrective actions.

Carmichael River sub plan is used as an example of the inconsistencies between Sections and Tables when referring to surveys, indicators, parameters and triggers. **See comparison Table at the end of this response for Carmichael River and Doongmabulla springs.**

The linkage between the information provided in the GDEMP.



The ecological trigger levels that will be applied in the GDEMP are summarised in Section 5.5. However, this is not consistent with other sections within the report. The indicators that are listed in Section 6.6.1 and 6.6.2 for the Carmichael River are not the same as the indicators listed in Table 5-1 or Table 6-9. In addition, there are indicators in Table 6-10 which are not included in Section 6.6.1, 6.6.2 or Table 6-9. Ecological triggers in Table 6-10 should be provided for each indicator.

The indicators listed in Sections 6.6.1 and 6.6.2 are:

- Population structure
- Community condition
- Weeds and pests or weed cover and pests
- Riparian community health
- Fauna use of riparian habitat
- Canopy cover
- Wetland vegetation
- Threatened and endemic flora populations
- Spring wetland extent
- Groundwater level
- surface water level
- surface water flow
- Groundwater quality
- surface water quality
- presence of weed species
- extent of weed coverage
- presence of pest species
- extent of pest disturbance.

The list of indicators in Table 6-9 are:

- Riparian community health
- Fauna use of riparian habitat

- Weed and pests (within areas controlled by Adani)
- Groundwater Level
- Groundwater Quality
- Surface Water Flow (periods of flow)
- Surface Water Level (periods of no flow)
- Surface Water Quality.

The list of indicators in Table 6-10 are:

- Groundwater Level
- Groundwater Quality
- Surface Water Flow (periods of flow)
- Surface Water Level (periods of no flow)
- Surface Water Quality
- Early warning signs of subsidence, such as tilt, strain and displacement exceeding predictions at monitoring locations.
- Observations of cracking or ponding in the Carmichael River.
- Visual record
- pH
- Turbidity
- CORVEG attributes
- Canopy cover
- Visual evidence of disturbance or clearing
- Ecological survey indicators
- Area cleared
- Population structure
- Community condition
- Riparian community health
- Fauna use of riparian habitat
- Wetland vegetation
- Threatened and endemic flora populations
- Canopy cover
- Rehabilitation success parameters as listed in Appendix 2 of the EA (native fauna species, plant regeneration, weed abundance, pest abundance), erosion
- Fuel load levels and ground composition.
- Presence of weed species
- Extent of weed coverage
- Presence of feral animals
- Extent of damage from feral animals
- Visual observation and records
- Event monitoring for: dB(A)
- peak particle velocity (PPV)
- Event monitoring for: Total suspended particulate matter
- Observations of amount of light falling on Carmichael River

It may be that a number of indicators listed in Sections 6.6.1 and 6.6.2 are classed as parameters in Table 6-9. However, this is not the case for community condition or population structure. In addition, wetland vegetation, threatened and endemic flora populations and spring wetland extent are not listed in Table 6-9 but are included in Section 6.6.

In Section 6.6.1, the indicator of population structure is included in the riparian condition and aquatic ecology surveys. However, this indicator will measure different communities and this is not addressed in Table 6-9.

For example, early warning signs of subsidence and cracking and ponding in the Carmichael River are included as an indicator in Table 6-10 but not in the other sections. For indicators included in Table 6-10, that are not other sections above, it is important that the appropriate management plan be referred to in each case.

Threats and potential direct/indirect project impacts that are required to be addressed, as they apply to the Carmichael River, are identified Section 6.4 and listed below.

#	Potential Threat or Impact
1	Groundwater drawdown from mine dewatering
2	Subsidence from underground mining
3	Changes to surface water flows and flooding, including water discharge
4	Surface water quality degradation
5	Vegetation clearing and habitat loss, of approximately 5 hectares to build a bridge across the Carmichael River
6	Fire
7	Weeds and pest
8	Earthworks
9	Noise and vibration
10	Emissions (including dust)
11	Light spill and other visual impacts

Red highlight cells suggests where information is missing. Red text suggests that consistency with terminology is required.

GDE	Monitoring survey	Table 5-1 - Monitoring attributes or methods	Section 5.5 – Ecological triggers	Indicators from Section 6.6.1 – pre impact	Indicators from Section 6.6.2 - impact	Table 6-9 - indicator	Table 6-9 - Parameter	Relevant Table 6-10 Number	Suggested relevant Table 6-10 number
Carmichael River	Ecological features map of the Carmichael River	Threatened and endemic flora locations	Change in the presence of native flora species recorded at monitoring sites located in the riparian zone of the Carmichael River from ecology surveys completed in Spring and Autumn 2011						#5
		Weed and pest locations		Weeds and pests					#7
		Riparian vegetation composition and health		Riparian community health Population structure Community composition (assumed equivalent)				#5	#1, #3, #4, #5
		Fauna use of riparian habitat		Fauna use of riparian habitat					#5
		Areas of connectivity or disconnection with groundwater							#1
		Gaining / losing areas relative to groundwater							#1
		Location of deep pools							#1, #3
		Location of riffles							#1, #3
		Location and size of							#1, #3

GDE	Monitoring survey	Table 5-1 - Monitoring attributes or methods	Section 5.5 – Ecological triggers	Indicators from Section 6.6.1 – pre impact	Indicators from Section 6.6.2 - impact	Table 6-9 - indicator	Table 6-9 - Parameter	Relevant Table 6-10 Number	Suggested relevant Table 6-10 number
		aquatic macrophyte beds							
		Other key aquatic habitat features							#1, #3
	Riparian condition surveys	CORVEG and/or BioCondition surveys	Reduction in riparian forest canopy cover as determined from analysis of aerial photography from period 2010 to 2018. Riparian community health indicators (CORVEG and BioCondition data) deviate from baseline and pre-impact conditions	Riparian community health Population structure Community composition Canopy cover (assumed equivalent)	Riparian community health	Riparian community health	Structural formation, leaf litter cover, rock cover, bare ground, cryptogram cover, crown cover, species composition and cover (by species and by stratum), height of each strata, cover of coarse woody debris, number of large trees (eucalypt and non-eucalypt), diameter at breast height (DBH) of eucalypt and non-eucalypt trees, weed cover, erosion and severity, disturbances and severity, stem count for woody vegetation, basal area.	#5	#1, #3, #4, #5
				Weed cover and pests				#7	#7
				Fauna use of riparian habitat	Fauna use of riparian habitat	Fauna use of riparian habitat	Abundance of key species.		#5
				Wetland vegetation (unclear why this is included here)					Delete
				Groundwater level (described in text, but not included in list for pre-impact but included in impact)	Groundwater level				#1
	Aquatic Ecological Surveys	Vertebrate species presence, in particular at remnant pools		Population structure (assumed equivalent)					#1, #3, #4, #5

GDE	Monitoring survey	Table 5-1 - Monitoring attributes or methods	Section 5.5 – Ecological triggers	Indicators from Section 6.6.1 – pre impact	Indicators from Section 6.6.2 - impact	Table 6-9 - indicator	Table 6-9 - Parameter	Relevant Table 6-10 Number	Suggested relevant Table 6-10 number
		Ecological condition (e.g. using AusRivAS)	Macro-invertebrate sampling using AusRivAS methods - EPT (Ephemeroptera, Plecoptera and Trichoptera) ratios of macroinvertebrates fall below baseline values of 6.7% (Autumn) and 15.8% (Spring)	Community condition (assumed equivalent)					#1, #3, #4, #5
		Ecological patterns (macrophytes, fish, invertebrates)		Population structure (assumed equivalent)					#1, #3, #4, #5
				Weeds and pests					#7
				Riparian community health (unclear why included in this survey)					Delete
				Fauna use of riparian habitat (unclear why included in this survey)					Delete
				Spring wetland extent (unclear why included in this survey)					Delete
				Wetland vegetation (unclear why included in this survey)					Delete
		Ecological patterns (macrophytes, fish, invertebrates)		Threatened and endemic flora locations (macrophytes)?					?

GDE	Monitoring survey	Table 5-1 - Monitoring attributes or methods	Section 5.5 – Ecological triggers	Indicators from Section 6.6.1 – pre impact	Indicators from Section 6.6.2 - impact	Table 6-9 - indicator	Table 6-9 - Parameter	Relevant Table 6-10 Number	Suggested relevant Table 6-10 number
	Groundwater monitoring	Groundwater level and quality		Groundwater level	Groundwater level	Groundwater level	Groundwater level	#1	#1
				Groundwater quality	Groundwater quality	Groundwater quality	Water quality parameters as outlined in GMMP.	#1, #4	#1, #4
					Groundwater drawdown rate should be included as an indicator				#1
	Surface water monitoring	Surface water level, flow and quality		Surface water level	Surface water level	Surface Water Level (periods of no flow)	Surface Water Level (periods of no flow)	#1, #3	#1, #3
				Surface water flow	Surface water flow	Surface Water Flow (periods of flow)	River discharge	#1, #3	#1, #3
				Surface water quality	Surface water quality	Surface water quality	Water quality parameters as outlined in REMP.	#1, #3, #4	#1, #3, #4
	Weed and pest surveys	Presence of weed species and extent of coverage	<p>Weed species recorded at riparian monitoring sites on the Carmichael River that did not have that weed species recorded during ecology surveys completed in Spring and Autumn 2011.</p> <p>Identification of new weed or pest species at any location along the riparian zone of the Carmichael River</p>	presence of weed species	presence of weed species	Weed and pests (within areas controlled by Adani)	<p>Inventory of all weed and pest species present.</p> <p>Identify spatial extent of weeds, especially Rubber Vine, along the Carmichael River.</p> <p>Identify areas of Riparian habitat subject to pig damage. (this should be more than just pig damage)</p>	#7	#7
			New population or	extent of weed coverage	extent of weed			#7	#7

GDE	Monitoring survey	Table 5-1 - Monitoring attributes or methods	Section 5.5 – Ecological triggers	Indicators from Section 6.6.1 – pre impact	Indicators from Section 6.6.2 - impact	Table 6-9 - indicator	Table 6-9 - Parameter	Relevant Table 6-10 Number	Suggested relevant Table 6-10 number
			area affected by weed or pests		coverage				
		Presence of pest species and extent of disturbance	<p>New population or area affected by weed or pests</p> <p>Identification of new weed or pest species at any location along the riparian zone of the Carmichael River.</p>	presence of pest species	presence of pest species			#7	#7
			New population or area affected by weed or pests	extent of pest disturbance	extent of pest disturbance			#7	#7

Memorandum



Enquiries Sonia Claus

Department of
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Your reference

Our reference WRNB 2278
(<http://wgsci.lands.resnet.qg/workrequest/>)

24/05/2019

To	Juliana McCosker, Manager
	Emerald Office, Coal Business Centre Department of Environment and Science
From	Dr Sonia Claus, Principal Scientist
	Water Sciences, Environmental Monitoring and Assessment, Science Delivery, Department of Environment and Science
Provided through	Dr Ian Ramsay, Science Leader

Subject: Review of Carmichael Coal project Groundwater Dependant Ecosystem Management Plan

Further to your work request dated 10/4/2019, the Water Sciences group has reviewed the Groundwater Dependant Ecosystem Management Plan (GDMP).

Advice provided by CSIRO and GeoScience Australia (GA) and the summary of that advice and Adani's response prepared by Department of Environment and Energy (DoEE) were also reviewed.

The specific information provided for the review included:

- AECOM 2019. Groundwater Management and Monitoring Program. Carmichael Coal Project. 15 March 2019. Version 7.
- Ecological 2019. Groundwater Dependant Ecosystem Management Plan. Carmichael Coal Mine Project. 19 March 2019. Version 11b
- CSIRO and GeoScience Australia. 2019. Carmichael Coal Mine. Advice on Groundwater Management and Monitoring and Groundwater Dependent Ecosystem Management plans to the Department of the Environment and Energy. February 2019.
- DoEE. 2019. Summary of CSIRO and Geoscience Australia Advice on Groundwater Management Plans and Response.

Water Sciences also attended a briefing on 16th April by CSIRO, GA and DoEE regarding the advice and Adani's responses and revisions to the groundwater management plans. A summary of the advice and Adani's responses is provided in WRNB 2278 GMMP.

Comments

Condition I11 - The proponent must develop and implement a Groundwater Dependent Ecosystems Management Plan (GDEMP) to detail the management of threats to defined environmental values and to report results and corrective actions for each GDE over the full period of mining activities and for a period of five years post mining rehabilitation.

There are numerous inconsistencies between Sections and Tables when referring to surveys, indicators, parameters and triggers. See detailed examples below.

Due to the inconsistencies throughout the GDEMP, it is suggested that a summary of all the surveys and indicators/parameters that will be monitored for each GDE as part of the GDEMP be included in the GDEMP. This is to ensure that all appropriate data is collected and not overlooked. A revision of the GDEMP should also be done to improve the consistency between and within sections and tables.

It is acknowledged that the triggers and corrective actions may need to be revised after monitoring commences. A commitment to update the GDEMP with proposed triggers for all indicators/parameters after 12 months should be included in the GDEMP.

Condition I13 - For the purposes of conditions I11 and I12, the GDEs include the affected Carmichael River riparian zone (ecosystems associated with the Carmichael River between Doongmabulla Springs and the Belyando River, including populations of Waxy Cabbage Palm), the Lignum, Stories and Mellaluka springs and the Doongmabulla Springs-complex.

Condition I14 - A report of the findings of this GDEMP, including all monitoring results and interpretations, must be prepared annually and made available on request to the administering authority. The report must include:

- a) An assessment of background reference groundwater levels (see condition E9).*
- b) The condition of each GDE compared with previous monitoring results.*
- c) The suitability of current groundwater trigger thresholds (as defined in condition E13).*
- d) Detail on the effectiveness of avoidance, mitigation and management actions in curtailing adverse impacts on GDE ecosystems.*
- e) A description of any adaptive management initiatives implemented.*
- f) Any offsets required for residual impacts.*

Due to the inconsistency and lack of trigger values and corrective actions for all indicators in the GDEMP, it will be difficult to report on the condition of each GDE compared with previous monitoring results. It will also be difficult to detail the effectiveness of avoidance, mitigation and management actions in curtailing adverse impacts on GDE ecosystems or any adaptive management initiatives implemented. It is therefore suggested that a revision of the GDEMP to include propose triggers for all indicators/parameters and improve the consistency between and within sections and tables be done as discussed above.

Definition GDEMP

The plan must include:

1) A description and map of each GDE potentially or indirectly impacted by mining activities

Section 8.1 outlines additional features within the Doongmabulla Spring complex. The location of these new features should be provided on a figure within the GDEMP. If they are included on a figure, then the figure should be referred to in Section 8.1.

2) Detailed baseline monitoring (using QuickBird imagery or similar) to be undertaken on the specific ecology of each GDE, groundwater level, groundwater and surface water quality, threatened species and ecosystem function

Groundwater level is an indicator, however, it is also referred to as “depth to groundwater” within the GDEMP (e.g. page 85). It should be referred to as groundwater level throughout the GDEMP.

3) Detailed baseline research to establish:

a) the extent and ecological composition of each GDE, in accordance with the Wetland Monitoring Methodology for springs in the Great Artesian Basin (R Fensham, 2009) where applicable.

b) the source aquifer(s) for the groundwater supply to the GDE.

The groundwater monitoring locations within the GDEMP for the Carmichael River are within the alluvium and Clematis Sandstone only. The Tertiary Sediments was identified in the GMMP as a source aquifer to the Carmichael River, therefore groundwater monitoring locations within the Tertiary Sediment should be included in Table 6-7.

Section 8.3.6 discusses the properties of the Rewan Formation, however, there is a lack of certainty as to whether these properties are correct and a research plan is proposed. Reference to the proposed research plan and what the plan will include should be included within this section.

Section 8.3.7 discusses the alternative model scenario where the source of the springs is below the Clematis. However, there is another alternative scenario, that should be discussed in this section, where there is hydraulic connectivity between the geological units below and above the Rewan. This scenario can influence the modelled drawdown.

To add confidence to the conceptual model and numerical model, additional work must be completed prior to the model review. It is recommended that Adani consider the following additional work prior to undertaking the Model Re-run as required by Condition E6:

- Hydrochemistry assessment of all bores from all aquifers, springs and the Carmichael River. This should include piper plots or similar analysis to determine source aquifers and interactions between hydrogeological units.
- Analysis of rock properties from the cores of new nested bores to inform hydraulic connectivity within and between hydrogeological units.
- At least 12 sampling units that are not more than 2 months apart over a 2 year period of water level and quality data from the new nested bores as per Condition E3(b).
- Determine the age of groundwater using isotopic tracers
- Use soon to be released GA airborne electromagnetic survey data to ascertain hydrogeology in and around the Groundwater Dependent Ecosystems.

c) the natural variation of the groundwater level/pressure.

Section 8.8 refers to the installation of additional bores.

“The GMMP recommends the installation of additional bores, in order to evaluate the vertical gradients between hydrogeological units. These proposed additional monitoring bores will be completed in the Rewan Formation / Dunda Beds and will also be designated as early warning bores for vertical migration of potential drawdown from the deeper coal measures. They will be co-located, or within 500m of existing Clematis sandstone monitoring locations. (page 211-212)”

Further details regarding the location the new nested bores should also be included in the GDEMP.

The timeframe for installation and the location of the bores should be included, as per the GMMP. To determine the natural variation in groundwater level, at least 12 sampling events over a 2 year period, that are no more than 2 months apart, is required during the pre-impact period.

d) GDE ecosystem pressure response to groundwater level/pressure fluctuation.

4) A description of how the results of baseline research and annual monitoring are to be used to determine any changes in GDE ecology attributable to mining activities.

It is important to include timeframes on the completion of pre-impact surveys and the revised GDEMP referred to in Section 5.4.4 (page 33). As this will be different for each GDE, it is unclear how this will be achieved. For the springs (DCS and Mellaluka) this would be after 19 years. However, for the Carmichael River and Waxy Cabbage Palms this is potentially after 3 and 10 years respectively, based on Appendix C.

Section 8.7.2 and 9.8.1 refers to an ecological condition report that will be prepared after pre-impact surveys. A timeframe should be provided as to when this report will be delivered (e.g. xx months after pre-impact surveys are completed). Section 8.7.2 indicates that the impact surveys will begin after excavation of the first box cut. The findings from the pre impact survey are required for interpretation of impact survey results. Therefore, the report should be finalised within 12 months of the excavation of the first box cut.

Section 5.5 Ecological trigger levels - the heading of this section is ecological trigger levels. However, groundwater and surface water quality and quantity triggers are discussed. It may be clearer to have water quality and quantity as a separate section to the ecological measures.

It is also unclear in this section how these ecological triggers levels relate to the attributes that are listed in Table 5.1 or indicators listed under each sub plan. There is a need for consistency when referring to monitoring surveys, monitoring attributes, indicators and parameters throughout the GDEMP.

Groundwater drawdown rate should be described and included as an indicator in all relevant sections of the GDEMP (e.g. Section 6.7.3 and Section 8.7.3).

The surface water quality and quantity monitoring and indicators are set out in the REMP. It is suggested that the REMP design be reviewed to ensure that the surface water monitoring proposed is sufficient for the monitoring and management of GDEs.

Table 6-1 provides the water quality objectives (WQOs) for the Carmichael River. A number of WQOs have been derived based on the 80th percentile of the Carmichael River data. The data used

to calculate the 80th percentiles has not been provided. The cobalt WQOs should also be updated to reflect the low reliability ANZECC trigger value of 1.4 µg/L, not the model mining conditions.

Section 7.6.1 states that “The exact location of monitoring sites will be finalised during the survey and establishment of gauging stations for the groundwater monitoring and surface water monitoring programs. A minimum of two impact sites will be associated with gauging stations, to allow interpretation of health with groundwater depth and surface water and groundwater interactions.” Further clarification is required. It is suggested that it should read “The exact location of **Waxy Cabbage Palm** monitoring sites will be finalised during the survey and establishment of ~~gauging stations for the groundwater monitoring~~ **bores** and surface water monitoring ~~programs~~ **sites**. A minimum of two **Waxy Cabbage Palm** impact sites will be associated with ~~gauging stations~~ **groundwater monitoring bores and surface water monitoring sites**, to allow interpretation of health with groundwater depth and surface water and groundwater interactions.”

Appendix B - Groundwater level thresholds - Bore C025P1 is crossed out. Does this mean that this bore is removed from the monitoring program?

The groundwater quality trigger values for the Alluvium and Tertiary sediments are repeated in Appendix B. The groundwater trigger levels should be consistent with the GMMP. Any changes that were made in the GMMP to the triggers should be updated in the GDEMP.

Section 8.7.4 within the Carmichael River Monitoring Section – it is unclear why groundwater level and quality trigger have only been provided for **some** bores in Appendix B. As per “*Corresponding groundwater level and quality trigger levels for **some of** these bores, as well as additional bore monitoring being conducted in the first two-year program prior to the groundwater model rerun, are provided in **Appendix B**.*”

It is suggested that “some of” be detailed from the sentence.

The text regarding the model re-run in Section 8.7.4 should be consistent with the EA conditions. Current text states “*Groundwater modelling will be re-run as new information becomes available as per EA and EPBC Act approval conditions (within 2 years of commencement of mining activities and every 5 years thereafter).*” However, this should be within 2 years after excavation of the first box cut.

Section 8.7.4 refers to “*Additional studies to determine the interaction with groundwater and the EWR of the springs and threatened flora species will occur as part of the research program that Adani has committed to.*” A summary of what is included in the additional studies referred to in Section 8.7.4 should be included.

5) A description of the potential impact on each GDE from each project stage including impacts from subsidence, mine dewatering of aquifers, water discharge, hydrological changes and weed and pest infestation.

It is stated in Section 6.3.5 that “*Aquatic weeds were noted in additional assessments conducted further upstream at the Doongmabulla Springs-complex associated with the Joshua Springs-group.*” However, the species that were observed have not been provided in the GDEMP. The aquatic weed species should be identified and included in the GDEMP.

It is stated in Section 8.6 that “*Activities associated with aquifer drawdown are not expected to commence until approximately 2020, with the reduction in pressure of the aquifers expected after approximately 20 years (GHD 2014).*” Are these dates correct? Will activities associated with

drawdown commence in 2020. In addition, Figure 25 in the GMMP has drawdown occurring after 10 years in the Rewan groundwater bore (C555P1).

Section 6.6.1 refers to surface water flow monitoring. "Surface water flow will be monitored daily and analysed monthly (through all project phases) at the existing monitoring locations noted in **Table 6-8**, at a minimum of three sites (at least one upstream, one downstream and one in the area where drawdown is greatest) along the Carmichael River (**Figure 6-16**) and at control sites on the Belyando River (**Figure 6-16**). Adani will also install two additional stream flow gauging stations, one between the Doongmabulla Springs and the western edge of the mining lease, the other downstream of the eastern edge of the mining lease and upstream of the Belyando River confluence."

Based on the above text and Table 6-8 and Figure 6-16, there will be 3 flow gauging stations on the Carmichael River, 2 on the Belyando River and 2 new gauging stations (Doongmabulla Springs and Carmichael River u/s of Belyando River). The location of the surface water gauging stations needs to be clarified and consistent with the GMMP.

6) Mitigation measures to be undertaken to avoid, mitigate, offset and manage impacts to GDE environmental values resulting from each stage of the project.

In Sections 6.8, 7.8, 8.6.1 and 9.7.1 a step should be included that states appropriate mitigation measures will be implemented if required. The adaptive management section for the Mellaluka Springs should include reference to Condition E13 and E14 as per the other GDEs.

It is stated in Section 10 that "Adani will integrate the management plan commitments with other aspects of the mine construction and operations, to avoid actions being overlooked." It would be good to provide a summary of these management plan commitments, so that they can easily be integrated into the mine operations.

Consistency and implementation of the GDEMP

Advice has been provided previously on numerous occasions that there was a lack of consistency between sections and tables within the GDEMP.

At the Technical Workshop on Groundwater Management Plan (7/11/2018), the issue of consistency was discussed and the meeting notes state *“Regulators suggested Adani clearly link baseline data and pre-impact monitoring to the monitoring required for both performance criteria and triggers, and also that monitoring was described before the tables with performance criteria, etc.”*

Advice was provided to ESR on 13/11/2018 on Version 10 (dated 9/11/2018) - main issues identified were -

- Conceptual model missing Joe Joe Group and Mellaluka Springs.
- The use of *interim* and *initial* trigger levels – it was decided at the meeting (7th Nov) that interim and initial would not be used?
- Consistency in how the groundwater level/drawdown triggers are referred to between sections.
- Consistency between the trigger values in Part 1 and the individual GDE sections is still missing. Also where trigger values are the same, for example between Carmichael River and Waxy Cabbage Palms.
- The Status and Description Section and the Summary of Baseline Monitoring Section could be combined in the individual GDE Sections.
- The Impact Monitoring and Triggers Sections need to be better separated or combined as there is a lot of repetition. For example, If separate Section 6.6.2 should better describe the methodology to monitor the indicators and Section 6.7 should outline the triggers and how they would be applied.
- Approach to statistical analysis table is missing in the Carmichael GDE section.
- The link between the indicators and statistical analysis table and the Management objectives table is needed in each GDE section.
- Groundwater quality trigger levels have not been included in the Appendices.

A pdf version of the GDEMP Version 10 with comments was provided to ESR with these main issues.

A revised version dated 20/11/2018 was reviewed as a response (WRNB 2157) was provided to ESR on 14/12/2018 which again identified that there was a lack of consistency between the statistical analysis and corrective action tables for each GDE. Specific comments on the surface and groundwater quantity and quality aspects of the tables was provided as an example of the level of consistency that was required throughout the GDEMP (not just when referring to surface and groundwater quality). This long standing issue is still to be addressed.

The issue of consistency within and between sections is important to meet the objectives of the GDEMP (page 1-2), in particular:

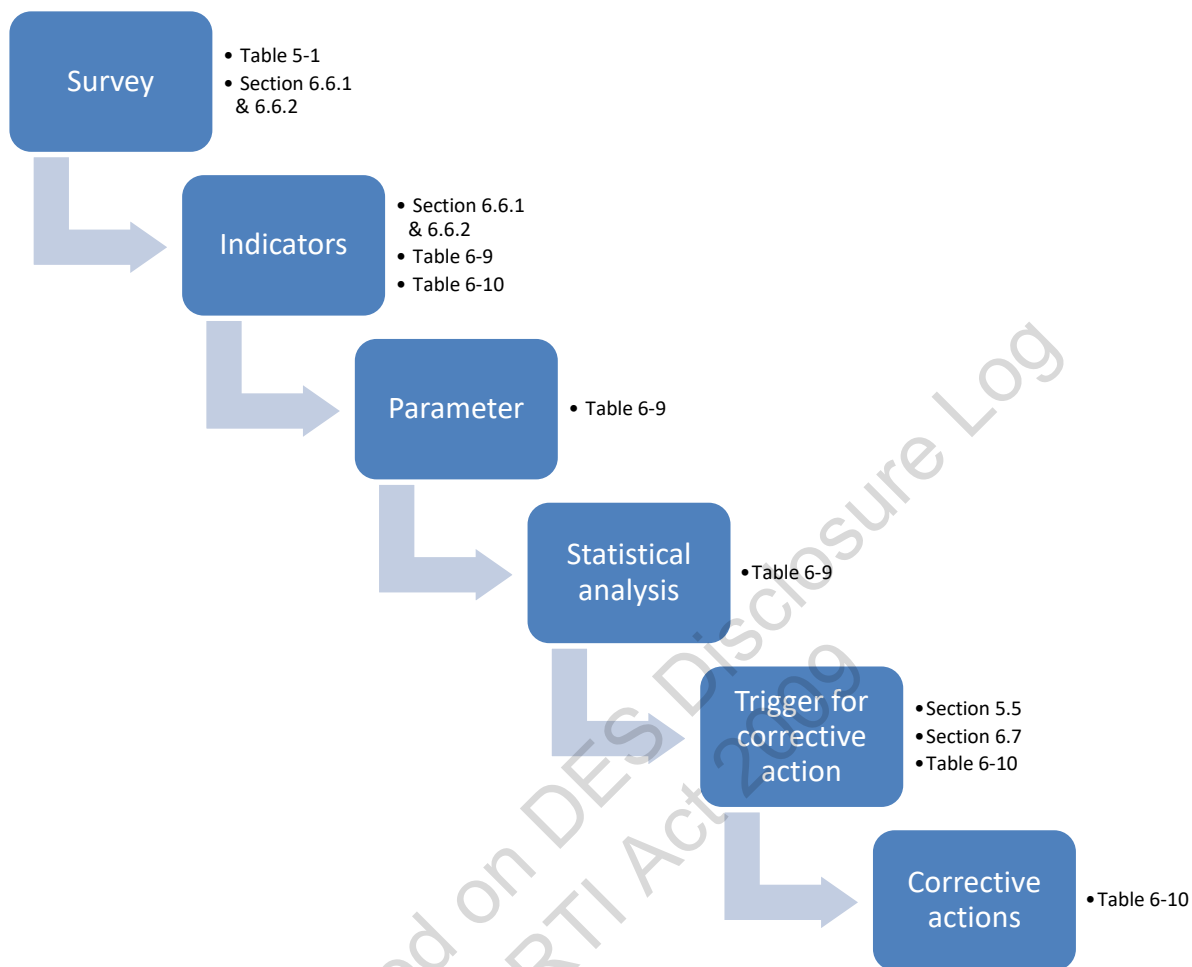
- Detail the monitoring program for both pre-impact and impact phases of the project, including how this monitoring will inform relevant mitigation, management and offset measures
- Describe mitigation and management measures with specific criteria, timing, performance objectives, goals and corrective measures.

It is stated on page 6 of the GDEMP that each management sub-plan in the GDEMP is structured to provide information in a consistent format on:

- Proposed monitoring program for the GDE across the pre-impact and impact stages
- Proposed triggers for both groundwater and ecological values of the GDE
- Details of mitigation and management measures to be implemented, including corrective actions.

Carmichael River sub plan is used as an example of the inconsistencies between Sections and Tables when referring to surveys, indicators, parameters and triggers. **See comparison Table at the end of this response for Carmichael River and Doongmabulla springs.**

The linkage between the information provided in the GDEMP.



The ecological trigger levels that will be applied in the GDEMP are summarised in Section 5.5. However, this is not consistent with other sections within the report. The indicators that are listed in Section 6.6.1 and 6.6.2 for the Carmichael River are not the same as the indicators listed in Table 5-1 or Table 6-9. In addition, there are indicators in Table 6-10 which are not included in Section 6.6.1, 6.6.2 or Table 6-9. Ecological triggers in Table 6-10 should be provided for each indicator.

The indicators listed in Sections 6.6.1 and 6.6.2 are:

- | | |
|--|-------------------------------|
| • Population structure | • Spring wetland extent |
| • Community condition | • Groundwater level |
| • Weeds and pests or weed cover and pests | • surface water level |
| • Riparian community health | • surface water flow |
| • Fauna use of riparian habitat | • Groundwater quality |
| • Canopy cover | • surface water quality |
| • Wetland vegetation | • presence of weed species |
| • Threatened and endemic flora populations | • extent of weed coverage |
| | • presence of pest species |
| | • extent of pest disturbance. |

The list of indicators in Table 6-9 are:

- Riparian community health
- Fauna use of riparian habitat
- Weed and pests (within areas controlled by Adani)
- Groundwater Level
- Groundwater Quality
- Surface Water Flow (periods of flow)
- Surface Water Level (periods of no flow)
- Surface Water Quality.

The list of indicators in Table 6-10 are:

- | | |
|---|---|
| <ul style="list-style-type: none"> • Groundwater Level • Groundwater Quality • Surface Water Flow (periods of flow) • Surface Water Level (periods of no flow) • Surface Water Quality • Early warning signs of subsidence, such as tilt, strain and displacement exceeding predictions at monitoring locations. • Observations of cracking or ponding in the Carmichael River. • Visual record • pH • Turbidity • CORVEG attributes • Canopy cover • Visual evidence of disturbance or clearing • Ecological survey indicators • Area cleared • Population structure • Community condition • Riparian community health | <ul style="list-style-type: none"> • Fauna use of riparian habitat • Wetland vegetation • Threatened and endemic flora populations • Canopy cover • Rehabilitation success parameters as listed in Appendix 2 of the EA (native fauna species, plant regeneration, weed abundance, pest abundance), erosion • Fuel load levels and ground composition. • Presence of weed species • Extent of weed coverage • Presence of feral animals • Extent of damage from feral animals • Visual observation and records • Event monitoring for: dB(A) • peak particle velocity (PPV) • Event monitoring for: Total suspended particulate matter • Observations of amount of light falling on Carmichael River |
|---|---|

It maybe that a number of indicators listed in Sections 6.6.1 and 6.6.2 are classed as parameters in Table 6-9. However, this is not the case for community condition or population structure. In addition, wetland vegetation, threatened and endemic flora populations and spring wetland extent are not listed in Table 6-9 but are included in Section 6.6.

In Section 6.6.1, the indicator of population structure is included in the riparian condition and aquatic ecology surveys. However, this indicator will measure different communities and this is not addressed in Table 6-9.

For example, early warning signs of subsidence and cracking and ponding in the Carmichael River are included as an indicator in Table 6-10 but not in the other sections. For indicators included in Table 6-10, that are not other sections above, it is important that the appropriate management plan be referred to in each case.

Threats and potential direct/indirect project impacts that are required to be addressed, as they apply to the Carmichael River, are identified Section 6.4 and listed below.

#	Potential Threat or Impact
1	Groundwater drawdown from mine dewatering
2	Subsidence from underground mining
3	Changes to surface water flows and flooding, including water discharge
4	Surface water quality degradation
5	Vegetation clearing and habitat loss, of approximately 5 hectares to build a bridge across the Carmichael River
6	Fire
7	Weeds and pest
8	Earthworks
9	Noise and vibration
10	Emissions (including dust)
11	Light spill and other visual impacts

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Red highlight cells suggests where information is missing. Red text suggests that consistency with terminology is required.

GDE	Monitoring survey	Table 5-1 - Monitoring attributes or methods	Section 5.5 – Ecological triggers	Indicators from Section 6.6.1 – pre impact	Indicators from Section 6.6.2 - impact	Table 6-9 - indicator	Table 6-9 - Parameter	Relevant Table 6-10 Number	Suggested relevant Table 6-10 number
Carmichael River	Ecological features map of the Carmichael River	Threatened and endemic flora locations	Change in the presence of native flora species recorded at monitoring sites located in the riparian zone of the Carmichael River from ecology surveys completed in Spring and Autumn 2011						#5
		Weed and pest locations		Weeds and pests					#7
		Riparian vegetation composition and health		Riparian community health Population structure Community composition (assumed equivalent)				#5	#1, #3, #4, #5
		Fauna use of riparian habitat		Fauna use of riparian habitat					#5
		Areas of connectivity or disconnection with groundwater							#1
		Gaining / losing areas relative to groundwater							#1
		Location of deep pools							#1, #3
		Location of riffles							#1, #3
		Location and size of aquatic macrophyte beds							#1, #3
		Other key aquatic habitat features							#1, #3
	Riparian condition surveys	CORVEG and/or BioCondition surveys	Reduction in riparian forest canopy cover as determined from analysis of aerial photography from period 2010 to 2018. Riparian community health indicators (CORVEG and BioCondition data) deviate from baseline and pre-impact conditions	Riparian community health Population structure Community composition Canopy cover (assumed equivalent)	Riparian community health	Riparian community health	Structural formation, leaf litter cover, rock cover, bare ground, cryptogram cover, crown cover, species composition and cover (by species and by stratum), height of each strata, cover of coarse woody debris, number of large trees (eucalypt and non-eucalypt), diameter at breast height (DBH) of eucalypt and non- eucalypt trees, weed cover, erosion and severity, disturbances and severity, stem count for woody vegetation, basal area.	#5	#1, #3, #4, #5
				Weed cover and pests				#7	#7
				Fauna use of riparian habitat	Fauna use of riparian habitat	Fauna use of riparian habitat	Abundance of key species.		#5
				Wetland vegetation (unclear why this is included here)					Delete
				Groundwater level (described in text, but not included in list for pre-impact but included in impact)	Groundwater level				#1
	Aquatic Ecological Surveys	Vertebrate species presence, in particular at remnant pools		Population structure (assumed equivalent)					#1, #3, #4, #5
		Ecological condition (e.g. using AusRivAS)	Macro-invertebrate sampling using AusRivAS methods - EPT (Ephemeroptera, Plecoptera and Trichoptera) ratios of macroinvertebrates fall below baseline values of 6.7% (Autumn) and 15.8% (Spring)	Community condition (assumed equivalent)					#1, #3, #4, #5
		Ecological patterns (macrophytes, fish, invertebrates)		Population structure (assumed equivalent)					#1, #3, #4, #5
				Weeds and pests					#7
				Riparian community health (unclear why included in this survey)					Delete
				Fauna use of riparian habitat (unclear why included in this survey)					Delete
				Spring wetland extent (unclear why included in this survey)					Delete
				Wetland vegetation					Delete

GDE	Monitoring survey	Table 5-1 - Monitoring attributes or methods	Section 5.5 – Ecological triggers	Indicators from Section 6.6.1 – pre impact	Indicators from Section 6.6.2 - impact	Table 6-9 - indicator	Table 6-9 - Parameter	Relevant Table 6-10 Number	Suggested relevant Table 6-10 number
				(unclear why included in this survey)					
		Ecological patterns (macrophytes, fish, invertebrates)		Threatened and endemic flora locations (macrophytes)?					?
	Groundwater monitoring	Groundwater level and quality		Groundwater level	Groundwater level	Groundwater level	Groundwater level	#1	#1
				Groundwater quality	Groundwater quality	Groundwater quality	Water quality parameters as outlined in GMMP.	#1, #4	#1, #4
					Groundwater drawdown rate should be included as an indicator				#1
	Surface water monitoring	Surface water level, flow and quality		Surface water level	Surface water level	Surface Water Level (periods of no flow)	Surface Water Level (periods of no flow)	#1, #3	#1, #3
				Surface water flow	Surface water flow	Surface Water Flow (periods of flow)	River discharge	#1, #3	#1, #3
				Surface water quality	Surface water quality	Surface water quality	Water quality parameters as outlined in REMP.	#1, #3, #4	#1, #3, #4
	Weed and pest surveys	Presence of weed species and extent of coverage	Weed species recorded at riparian monitoring sites on the Carmichael River that did not have that weed species recorded during ecology surveys completed in Spring and Autumn 2011.	presence of weed species	presence of weed species	Weed and pests (within areas controlled by Adani)	Inventory of all weed and pest species present. Identify spatial extent of weeds, especially Rubber Vine, along the Carmichael River. Identify areas of Riparian habitat subject to pig damage. (this should be more than just pig damage)	#7	#7
			Identification of new weed or pest species at any location along the riparian zone of the Carmichael River						
			New population or area affected by weed or pests	extent of weed coverage	extent of weed coverage			#7	#7
		Presence of pest species and extent of disturbance	New population or area affected by weed or pests	presence of pest species	presence of pest species			#7	#7
			Identification of new weed or pest species at any location along the riparian zone of the Carmichael River.						
			New population or area affected by weed or pests	extent of pest disturbance	extent of pest disturbance			#7	#7

GDE	Monitoring survey	Table 5-1 - Monitoring attributes or methods	Section 5.5 – Ecological triggers	Indicators from Section 8.7.1 – pre impact	Indicators from Section 8.7.3 - impact	Table 8-9 - indicator	Table 8-9 - Parameter	Relevant Table 8-10 Number	Suggested relevant Table 8-10 number
Doongmabulla Spring complex	Spring Monitoring	Spring-head pressure							1
		Flow rate (if measureable)		Flow rate (surface water monitoring)	Spring flow				1
	Mound Springs data	Mound springs diameter, height and perimeter	Deviation from baseline conditions of mound springs characteristics (maximum diameter, height, perimeter length, full floristics species composition and abundance, abundance of spring endemic flora species, abundance of threatened species)	Mound springs – no indicators specified					1
		Full floristic species composition and abundances	Deviation from baseline conditions of mound springs characteristics	Mound springs – no indicators specified					1, 6
		Population surveys for spring endemic flora species	Absence of GAB spring endemic species observed in Moses Spring in 2012 and 2013 baseline surveys	Mound springs – no indicators specified					1, 6
		Population surveys for Commonwealth and State listed species	Deviation from baseline conditions of mound springs characteristics	Mound springs – no indicators specified					1, 6
		Photographic references (photo point monitoring)		Mound springs – no indicators specified					1
	Wetland vegetation monitoring	Identify wetland zones and their boundary locations	Reduction in wetland area as determined from analysis of aerial photography from period 2010 to 2018.	Spring wetland extent (habitat features survey) (assumed equivalent)			Perennial wetland cover assessed both on site and via remote sensing.	5	1
		Photographic references (photo point monitoring)					Photographic reference		1
		Wetland vegetation species composition	Deviation from baseline conditions of wetland vegetation characteristics (area of wetland zones, vegetation species composition and vegetation species abundance)	wetland vegetation zone native vegetation cover (assumed equivalent)		Wetland vegetation species composition	Identify wetland zones (pool, saturated, damp, dry) and their boundary locations. Wetland vegetation species composition	1, 6	
		Wetland vegetation species abundances	Deviation from baseline conditions of wetland vegetation characteristics (area of wetland zones, vegetation species composition and vegetation species abundance)			Wetland vegetation species abundances	Wetland vegetation Species abundances (1 m x 1 m subplots spaced 4 m apart, along the transect)		1, 6
	Threatened and endemic flora populations	Targeted surveys for threatened and endemic flora populations at each spring head in the Moses Springs-group and each springs wetland	Deviation from baseline conditions in the number and abundance of threatened and endemic flora species	Threatened and endemic species presence, condition and location	Threatened and endemic species presence, condition and location	Threatened and endemic flora populations	Location, extent and condition of <ul style="list-style-type: none"> Waxy Cabbage Palm <i>Livistona lanuginosa</i> (Vulnerable – Moses) Blue Devil <i>Eryngium fontanum</i> (Endangered - Moses) Salt pipewort <i>Eriocaulon carsonii</i> subsp. <i>Oriental</i> (Endangered – Moses) <i>Hydrocotyle dippleura</i> (Vulnerable - Moses) <i>Isotoma</i> sp. 'RJ Fensham 3883' (Endemic – Moses) <i>Myriophyllum artesium</i> (Endangered – Moses and Joshua) <i>Sporobolus pamela</i> (Endangered – Moses) <i>Sporobolus partimpatens</i> (Near Threatened – Moses and Joshua) Any other flora identified during baseline surveys as endemic or threatened, and reliant on GAB spring wetlands for survival. 	1, 6	
	Aquatic invertebrate communities	Characterisation of aquatic macroinvertebrate communities	Deviation from baseline conditions of aquatic invertebrate communities (utilising AusRivAS protocols).						1

GDE	Monitoring survey	Table 5-1 - Monitoring attributes or methods	Section 5.5 – Ecological triggers	Indicators from Section 8.7.1 – pre impact	Indicators from Section 8.7.3 - impact	Table 8-9 - indicator	Table 8-9 - Parameter	Relevant Table 8-10 Number	Suggested relevant Table 8-10 number
		Macroinvertebrate genera and species richness		Macroinvertebrate genera and species richness				1	
	Stygofauna	Stygofauna presence and endemism		Stygofauna presence, stygofauna endemism				1	
	Groundwater monitoring	Groundwater level and quality		Groundwater level	Groundwater level	Groundwater level	Groundwater level	1	
				Groundwater quality	Groundwater quality	Groundwater quality	Water quality parameters as outlined in GMMP.	1	
					Groundwater drawdown rate should be included as an indicator				1
	Surface water monitoring	Spring wetland extent and water level	Deviation from baseline Spring wetland extent	Spring wetland extent (habitat features survey) (assumed equivalent)	Wetland extent (assumed equivalent)	Spring wetland extent	Perennial wetland cover assessed both on site and via remote sensing. Identify wetland zones (pool, saturated, damp, dry) and their boundary locations. Photographic reference	1	
				Spring wetland water level Wetland pool depth	Wetland level (assumed equivalent)			1	
		Surface water quality		Surface water quality	Surface water quality			2, 7	
				Flow rates				2	
	Weed and pest surveys	Presence of weed species and extent of coverage	Weed species recorded at riparian monitoring sites on the Carmichael River that did not have that weed species recorded during ecology surveys completed in Spring and Autumn 2011.	presence of weed species	presence of weed species			4	
			Identification of new weed or pest species at any location along the riparian zone of the Carmichael River						
			New population or area affected by weed or pests	extent of weed coverage	extent of weed coverage			4	
		Presence of pest species and extent of disturbance	New population or area affected by weed or pests	presence of pest species	presence of pest species			4	
			Identification of new weed or pest species at any location along the riparian zone of the Carmichael River.						
			New population or area affected by weed or pests	extent of pest disturbance	extent of pest disturbance			4	