MEMORANDUM - WESTERN DAVENPORT WATER ALLOCATION PLAN (2023-2033) AND SUPPORTING DOCUMENTS REVIEW

PREPARED FOR | Central Land Council - Northern Territory

PREPARED BY | Hydro Geo Enviro Pty Ltd, Dr Ryan Vogwill, Director

DATE | 2/05/2023

Introduction

In response to the request from the Central Land Council (CLC) the following documents have been reviewed by Hydro Geo Enviro:

- Draft WDWAP BACKGROUND Mar 2023.pdf;
- NEW Draft WAP Mar 2023.pdf; and
- DRAFT Implementation Actions MAR WAP.pdf.

This review will take the form of a summary, covering all the documents, followed by individual points identified during the review of each document. Also note that where pages numbers are referred to, these are the PDF file page numbers not those in the header/footer of the document.

Summary

The Water Allocation Plan (WAP) and associated documents (the background and implementation documents) have been reviewed in the context of the CLCs interests in the Western Davenport area. As an overall opening comment, The WAP has become more generic compared to previous versions. In many ways the WAP and associated documents contain less scientific detail than previous versions. In other jurisdictions in my experience these documents typically become more detailed and robust in progressive iterations. The risk assessment presented is highly subjective, I would have assigned higher residual risk ratings post the proposed management activities. The adaptive management framework is generic and often not specific enough.

With respect to comments and issues raised in my previous reviews, where these issues have now been included in the revised WAP and associated documents, they have not been substantively addressed. For example, predictive uncertainty and sensitivity analysis have been completed according to the background document for the WAP. But no detail or prediction ranges from these critical modelling outputs are presented or included in the depth to groundwater predictions, the assessment of drawdown and potential for groundwater dependant ecosystem (GDE) impacts.

In the context of predictive uncertainty, some of the relevant guiding principles from the Australian Groundwater Modelling Guidelines (Barnett et al., 2012) are as follows, with Guiding Principal 7.6 of particular relevance:

- Guiding Principle 6.1: All model predictions are uncertain. The modelling process should acknowledge and address uncertainty through an appropriate uncertainty analysis (refer to Chapter 7).
- Guiding Principle 7.1: Because a single ‘true’ model cannot be constructed, modelling results presented to decision-makers should include estimates of uncertainty.
- Guiding Principle 7.6: Uncertainty should be presented to decision-makers with visual depictions that closely conform to the decision of interest.

Another issue that has now been included in the revised WAP but not substantively addressed relates to aquatic and subterranean GDEs. Although they are included in the revised plan text no drawdown criteria (environmental water requirements) are presented to protect them. Aquatic GDE mapping is also from a 2009 source, so likely not up to date and is not exhaustive.

Critical documents that underpin the WAP (particularly in the case of the background document) have not been made available to the CLC when requested. The two main documents in this context are:

- Tickell, S.J. and Zaar, U., (2022 (in-press)). Groundwater resources of the Western Davenport area. Northern Territory Department of Environment, Parks and Water Security. Water Resources Branch, Technical Report 7/2022; and
- Groves, H. (2022). Western Davenport Water Allocation Plan Water Resource Status - Technical Note: Summary Update 2022.

In my opinion the reduced detail in this WAP even further calls into question allocation limits that are nearly twice the average annual net recharge in the Central Plains management area. The allocation limits/estimated sustainable yield (ESY) do not appear to be derived consistently for the various management areas. To be specific:

- For the Davenport Ranges management area, the net recharge is 13.5 GL and the allocation limit is 4.4 GL;
- For the Southern Ranges management area, the net recharge is 34.7 GL and the allocation limit is 1.8 GL; and
- in the Central Plains management area, the net recharge is 46.9 GL and the allocation limit is stated as 81.5 GL.

A comparison between the previous WAP version (2018-2021) and this version (2023-2033) shows that the allocation limit/ESY is very similar for the Central Plains management area (87.7 GL/yr to 81.5 GL/yr). In contrast in the Davenport Ranges (11 GL/yr to 4.4 GL.yr) and Southern Ranges (39.6 GL/yr to 1.8 GL/yr) management areas allocation limits have been considerably reduced.

For the Davenport and Southern Ranges management areas in my opinion the ESYs are consistent with a precautionary approach with ESYs considerably less than average annual recharge. This is however in contradiction to the ESY being nearly double average annual net recharge in the Central Plains management area. The Central Plains management area is the most vulnerable to impacts as it contains the most groundwater dependent biodiversity and cultural assets. It is also the area with the largest groundwater allocations licenses both granted and pending.

Climate in the groundwater model utilises the observed post 1970 data, which is a wetter period than the long-term average. The wetter period occurs primarily as an increased frequency of high rainfall years but periods of low rainfall also occur. It is important to better understand the sensitivity of groundwater levels in the area to this observed climate variability. I would recommend a groundwater model scenario-based analysis, which would assess the variability of groundwater levels under a range of climate scenarios. This scenario analysis would take the form of a series of years representing a dry period, a series of years representing an average period and a series of years representing a wet period. This would be a robust approach to look at the implications of the proposed ESY on groundwater levels and GDEs under a range of future climates. This should have been completed as part of the sensitivity analysis, which according to the WAP background document, has been completed but is not presented.

There is also an ongoing issue (in all of WAP versions) with the use of model derived highly uncertain groundwater levels to estimate the area of GDE impact risk. For example, the WAP background document correctly identifies that Thring Swamp is a high value biodiversity and cultural asset that

has a depth to groundwater of 5m or less. Available groundwater data from one of the bores near Thring Swamp (see figure below) show that the depth to groundwater at that location is consistently below 5m, has been 0m in 2011 (i.e. at the surface) and is generally about 1.5m. This area is predicted to impacted by drawdown but the lack of predictive uncertainty analysis of the groundwater modelling makes it difficult to assess the timing and magnitude of drawdown. The groundwater model does not accurately (see figure below) represent this important biodiversity asset/high cultural value site, which urgently needs a detailed assessment of aquifer connectivity and groundwater dependence. Showing all depth to groundwater contours <15m at 1m interval would be preferable to facilitate comparison with measured groundwater data.

As a final note, although it is outside the scope of this review, it may be prudent to assess how many of the previous WAP's implementation activities (see section 8.4.1 WAP implementation activities in the 2018-2021 WAP) have been completed and how many are being rolled into the current WAP version.

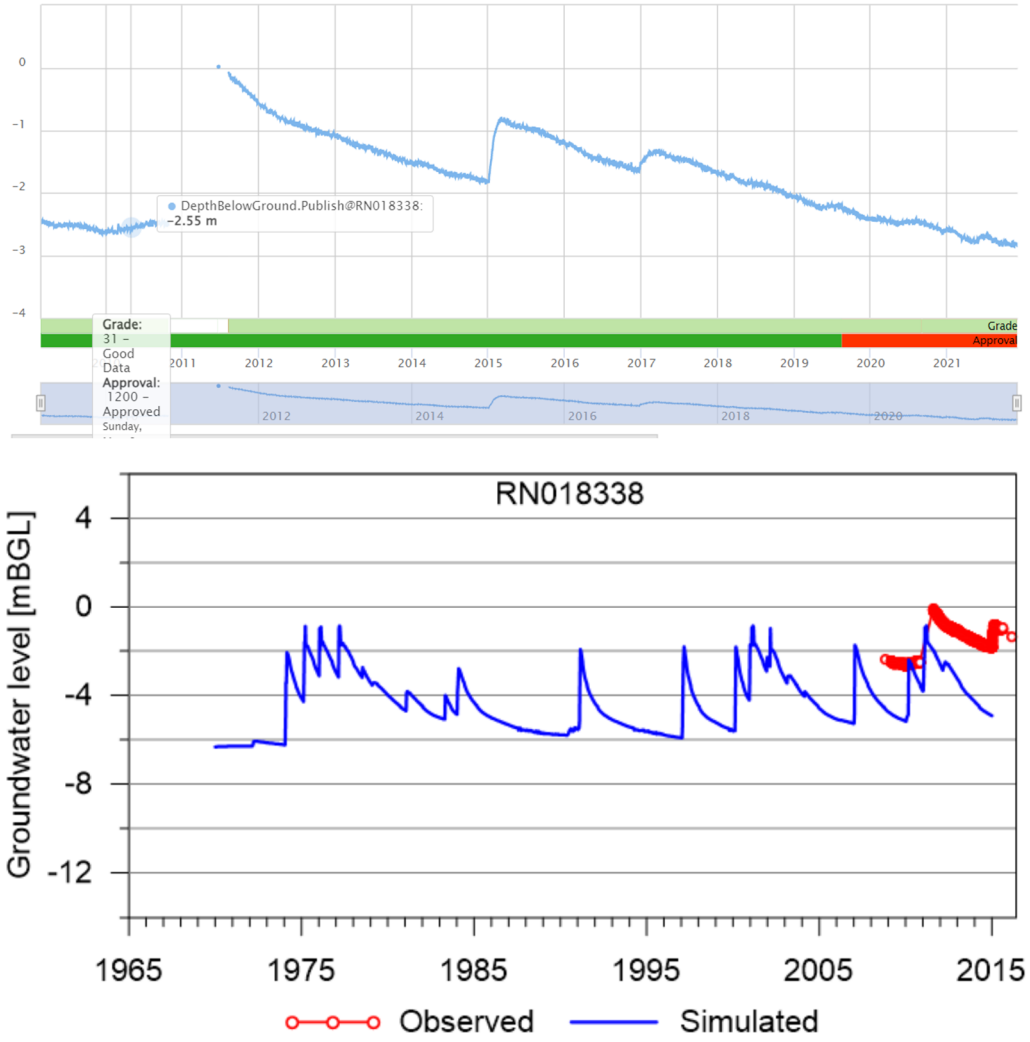

Figure - (Upper) Thring Swamp bore RN018338 (Lower) model calibration hydrograph from Knapton, (2017). Note the difference with the model prediction showing the bore fluctuating from ~2-6m below the surface instead of ~0-2m.

Review of Draft WDWAP BACKGROUND Mar 2023.pdf

Page 7 - "An updated water allocation plan for the period 2023 - 2033 (the draft plan) has been developed with input from the Western Davenport and Ti Tree Water Advisory Committee (the Committee)."

> Comment - Based on the comments from the committee I've read (Update on WDWAP - WAC meeting 24 Jan 2023.docx) all bar one committee member rejected this document and have major concerns with this WAP version and the revision process. The public consolation was posed as way to resolve this impasse. This statement suggests (indirectly) that the committee has approved this plan. I'd suggest that this is removed this until the committee has endorsed this plan.

Page 7 - "The result is a streamlined water allocation plan that meets the legislative requirements and is easy to read." and "As part of the department's commitment to the National Water Initiative".

> Comment - Although not core to my area of expertise I suspect that there are some issues with how well this meets many aspects of the NT and federal governments legislation especially the National Water Initiative (NWI). Clause 69 for example and note this NWI definition:
>
> > ***environmentally sustainable level of extraction*** – the level of water extraction from a particular system which, if exceeded would compromise key environmental assets, or ecosystem functions and the productive base of the resource.
>
> Proposed abstraction in the Central Plains is in excess of net recharge by some margin so will impact the productive base of the resource, impact to 30% of their definition of GDEs (which might be an underestimate and has no prioritisation or ranking od GDEs) may compromise key environmental assets.

Page 8 - "A detailed report on community engagement including the role and activities of the Committee, will be issued once consultation on the draft water allocation plan is complete, and the new plan is declared by the Minister."

> Comment - Given the Committee's comments on the plan this seem disingenuous. Their comments should be made public in this context?

Page 10 - "Central Plains - a large regional aquifer that is **high yielding**"

> Comment - High yielding hasn't been proven for the majority of the area.

Page 10 - "The understanding of the resources was improved through a number of key investigations conducted during 2018-2022 by the department, Geoscience Australia (GA), the National Water Grid Authority (NWGA) and other private companies. Data acquisition for these investigations included:"

> Comment - There is insufficient detail on these activities and limitations therein. For example, there is insufficient water monitoring data to provide a robust transient calibration for much of the model's domain. How much actual acquisition of data has occurred? Has all of this been incorporated in the model? It appears that the model and modelling report haven't been updated since the 2017 version that is cited in the WAP.

Page 10 - 3.2. Climate and rainfall

Comment - it is important to note that potential evaporation is higher than rainfall every month, this will limit the amount recharge that occurs to only during periods of intense rainfall. Average rainfall is less important than the frequency of high (>~50mm) rainfall events. SILO data is the best available so there is no issue with the use of that dataset. I also note that the assessment of rainfall events sufficient to cause recharge has occurred later in the document.

Page 13 - "Both charts provide evidence of an increasing trend in rainfall across the district since approximately 1972."

Comment - The data isn't that simple. An annotated version of the climate graph from the WAP background document is shown below. There is a period of average to less than average rainfall that spans 1980 to 2000 (see yellow arrows). The series of 4 significant rainfall years in the late 70's accounts for about half of the "increasing rainfall trend" at Ali Curung. This effect is even more pronounced in the Barrow Creek dataset with rising trend in the 4 late 1970's years, 2001, 2002, 2009 and 2010 accounting for this increasing trend.

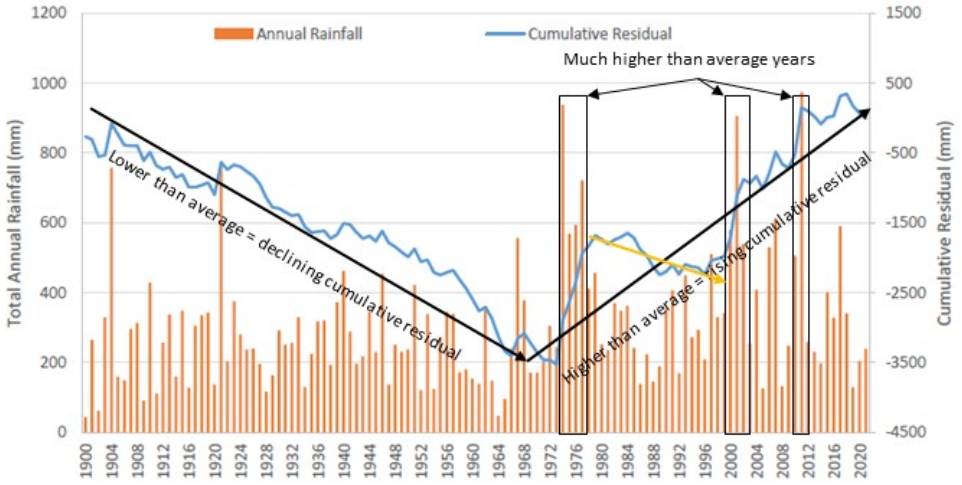

Figure 6. Cumulative residual rainfall (mm) measured at Ali Curung (BoM Station ID 015502)

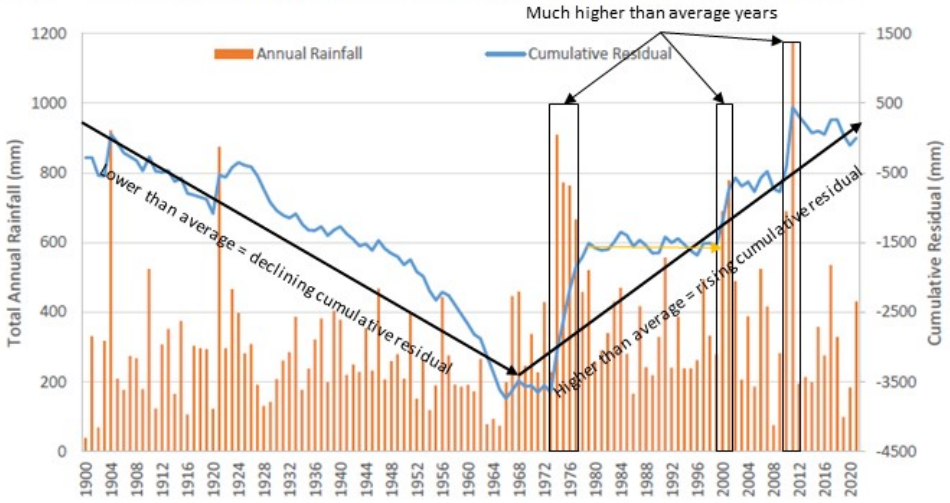

Figure 7. Cumulative residual rainfall (mm) measured at Barrow Creek (BoM Station ID 015525)

Page 15 - “Crosbie et al. (2013) states that results from such models should be presented using a risk analysis framework, which “incorporates the uncertainty associated with differences between Global Climate Models, thus [acknowledging] this inherent and possibly irreducible uncertainty””.

> Comment - I agree, as previously stated the NTG has not presented any uncertainty for their groundwater modelling used to underpin this plan.

Page 15 - “***This data inherently allows for other trends*** as noted in the State of the Climate 2020 Report, such as ***a decrease in the number of tropical cyclones*** in the Australian region since 1982, high variability of rainfall in northern Australia, and a continuing trend of more frequent compound extreme events (BoM & CSIRO, 2020).”

> Comment - It is unclear how the chosen groundwater modelling climate scenario ensures this (bolded italics text above) is the case. I would recommend that they do some scenario analysis on climate sensitivity (low, medium and high) with their models focussing on the frequency of extreme events, compound events and potential evaporation.

Page 15 - “These figures clearly highlight the difference between artificially simulated potential evaporation for the period 1900-1970 and observed or derived potential evaporation for the period 1970 to 2021.”

> Comment - The pre 1970’s data is not particularly useful or relevant as the groundwater model doesn’t cover this period. I also think that annual total potential evaporation would be a better way to look at the recent (post 70’s) data.

Page 16 - “The study concluded that new AEM data suggests the Cambrian units of the Wiso Basin and Georgina Basin are connected, and act as an equivalent hydrostratigraphic unit. However, it was reported that a more detailed interpretation and data infill in the area where the Wiso Basin and Georgina Basin meet would improve this conceptualisation.”

> Comment - It is not definitive in my experience to conclude this based on AEM data alone, you need some geology data (cores/drill logs) and some aquifer testing data which spans the hydrostratigraphic boundary.

Page 16 - “Hydrochemistry data also revealed that the Central Plains of the district is characterised by good quality groundwater, suggesting irrigated agriculture could be supported in this area.”

> Comment - This is a simplistic endorsement of irrigated agriculture in the area as it doesn’t include salinity risk etc.

Page 17 - “3.2.2.2. Mapping the Future”

> Comment - No references are included so we don’t know the exact source of these comments from the Mapping the Future (MtF) project.

Page 17 - 3.2.2.3. National Water Grid Authority

> Comment - This section is non-specific, has no references and no substantive results presented. This adds little apart from concluding “we don’t have enough data to make an informed decision of secondary salinisation risk.”

Page 18 - 3.3. Surface water resources

> Comment - This section talks more about surface water features than surface water resources. Misleading section name but not a substantive issue.

Page 18 - “However, these systems are highly important and interconnected with groundwater resources in the district.”

> Comment - I agree so why are these connections not shown in depth to groundwater maps or in assessments of these system as potential GDEs?

Page 18 - “Given that regional surface water resources are not permanent, baseflow contributions to watercourses sourced from groundwater are likely negligible.”

> Comment - This is an option as opposed to a proven scientific fact. The connection and contributions to surface water features will likely be site specific and should be investigated with detailed water balance studies for: (1) representative sites; (2) high biodiversity value GDEs (but ranking/priority for GDEs is unknown); and (3) high cultural value sites (such as Thring Swamp) regardless of their biodiversity values. Just because the surface water isn’t permanent that doesn’t mean there isn’t any groundwater inflow. There are many examples of ephemeral wetlands with a significant groundwater inflow component and high degrees of groundwater dependence.

Page 18 - “Smaller wetlands, such as swamps and claypans that are not connected by flood ways or channels, are generally filled intermittently via local rainfall, runoff from nearby rocky ranges, or from sheet-flow across the surrounding landscape”

> Comment - No relevant references cited, with only Duguid, A. (2009) cited. How has this been determined? Duguid, A. (2009) does not present anything that can confirm this statement. Figure 10 is from 2009 and I would think a more robust (and up to date) investigation of wetlands is required. Page 18 contains critically important statements regarding wetlands but there are no substantive studies to back these statements up.

Page 19 - The Hanson River Palaeochannel runs along the western side of the District from the Southern Ranges into the Central Plains, it hasn’t been assessed.

> Comment - The Nolan’s bore field exploration studies for the Ammaroo mine have investigated this area. They have used actual depth to groundwater data (not just model outputs) to define GDEs and have done some predictive uncertainty analysis. In my opinion their analysis of that area is more robust than the WD WAP.

Page 20 - Tickell and Zaar (2022) and “The report provides a comprehensive hydrogeological conceptualisation of the Western Davenport area based on the most recent data collected from the region. The report also includes a groundwater resource risk map, which categorises the Central Plains aquifer into risk categories associated with development of irrigated agriculture. The risks are based on aquifer properties including the capability of the aquifer to supply water, the depth of the water table and groundwater salinity.”

> Comment - Although this recent report is cited it is not available to review. If it underpins all of the recent hydrogeological setting and conceptualisation work, then this should be available at the same time as the Draft WAP so it can be assessed. The 3 WAP documents

(particularly the background document) need more of the detail contained in Tickell and Zaar (2022) if that document is not available for public review.

Page 21 - However, regional data indicates that overall lower yields are associated with depths greater than 150 mBGL in the Central Plains area. These lower yields may suggest that the practical extraction depth in this part of the area is around 150 mBGL.

Comment - If this is the case then the basement for the quantitative aspects of the WAP should be this depth if it is unlikely that there are productive aquifers below this point. This would substantially reduce storage estimates.

Page 22 - Tickell and Zaar (2022) provide further explanation of recharge processes as part of the Western Davenport MtF study.

Comment - See previous comments. Tickell and Zaar (2022) need to be available for review during the public comment period of the WD WAP.

Page 23 - The water table is a dynamic feature, which can rise and fall depending on available recharge or lack thereof (Tickell and Zaar, 2022).

Comment - The water table respond to more than recharge, this is simplistic. Transpiration and abstraction for example but also lateral charges in hydraulic aquifer properties (hydraulic conductivity, thickness etc).

Page 23 - "Additionally, there is limited evidence regarding constraint of regional groundwater flow due to the aquitards or structural features (Tickell, 2014; Knapton, 2017)."

Comment - These are relatively old references and the status of faults as barriers or conduits needs to be verified with aquifer testing. The predominantly steady state regional groundwater modelling generally won't identify these more subtle nuances of a flow system as steady state modelling doesn't incorporate a time component. A steady state model is run until it is in "steady state" so there are no changes over time, but when you introduce transient stresses (such as pumping) hydraulic barriers or conduits may become apparent.

Page 24 - Low salinity groundwater is common across the central portion of the district, with total dissolved solids (TDS) concentrations generally less than 3,000 mg/L.

Comment - 3000 mg/L isn't low salinity groundwater it's brackish. The salinity categories of the United States Geological Survey (USGS) for example would classify this as slightly (1,000 mg/L to 3,000 mg/L) to moderately saline water (3,000 mg/L to 10,000 mg/L).

Page 27 - "In 2016, the department engaged CloudGMS to develop a hydrogeological conceptualisation and numerical groundwater model (the model) for the district (Knapton, 2017)."

Comment - No update from previous modelling reports.

Page 28 - "The groundwater model was calibrated using history matching, a method commonly used to check that a computer model satisfactorily predicts past conditions. Because no suitable evaporation data was available for the Western Davenport area from the BoM prior to 1970, the 45 year period from 1970 to 2015 was chosen to calibrate the model and to estimate key model parameters. Modelled groundwater levels were compared with approximately 20,000 recorded groundwater level measurements available for the calibration period."

Comment - The majority of these 20,000 recorded measurements come from a very limited number of bores according to Knapton (2017).

Page 28 - “The model was also graded for reliability and sophistication using a classification system developed under the Australian Groundwater Modelling Guidelines 2012 (Barnett et al., 2012). The classifications range from Class 1 (lowest) to Class 3 (highest). While many characteristics of groundwater model were graded Class 3, the model was ultimately graded Class 2 owing to the limited availability of information to the south east and north west of the main (Central Plains) aquifer system.”

Comment - I think there are some elements closer to Class 1. Regardless, models of all classes (as per Barnett et al., 2012) need sensitivity and predictive uncertainty analysis to be presented to help put the predictions in a context of their uncertainty. See my previous review for more detail on this topic.

Page 29 - “Sensitivity and uncertainty analyses (extended in 2021) were also performed to quantify the response of the model’s output to incremental variations in model parameters, stresses and boundary conditions.”

Comment - We haven’t ever seen these and have repeatedly asked for their analysis in this context. I believe we were told that predictive uncertainty analysis was not possible but it has been previously completed and is now “extended” in 2021?

Page 30 - Figure 17. Natural water balance for the Western Davenport water management zones

Comment - Regarding the Central Plains Management Zone, assuming the aquifer inflows and outflows roughly balance (even though outflows are bigger than inflows) the average net recharge (recharge minus evapotranspiration) is 46.9 GL/yr. Referring forward to Table 3 the estimated sustainable yield is stated at 81.5 GL/yr which is twice annual net recharge. Under no reasonable definition of sustainable yield is this appropriate. It is managed depletion of the aquifer.

Page 30 - “The maximum aquifer thickness in the Central Plains water management zone is estimated to be greater than 1,200 mBGL while the average thickness is around 300 m.”

and

“The full volume of storage for these zones is deemed a reasonable estimate for productive use due to the relatively small aquifer thicknesses.”

Comment - Previously they have stated that the effective depth of recoverable groundwater was 150mBGL (page 21) this is contradictory.

Page 30 - “3.5.3. Modelling scenarios”

Comment - Where are these fully detailed (source)? What is the uncertainty on these predictions?

Page 31 - “3.6. Interconnectivity of groundwater and surface water”

Comment - This section presents no specific findings or citations and is of critical importance. It’s more about mapping surface water features and runoff.

Page 32 - “All three categories of GDEs are known to occur or are likely to occur within the district.”

and

“The type of GDE is strongly influenced by depth to groundwater”

> Comment - It is a positive step that this is included as previously subterranean and aquatic ecosystems were barely mentioned. However, no specific impact criteria have been presented or proposed for these types of GDE. Subterranean GDEs are not strongly influenced in all cases by depth to groundwater, it’s more about what type of subterranean habitat they can occur in and how proposed drawdown will impact that habitat. For subterranean fauna restricted to alluvium this could be a thin layer of alluvial sediments in the river/creek hyporheic zone.

Page 33 - “To map the probable occurrence of GDEs, Brim Box et al. (2022) applied singular value decomposition to a time-series of vegetation indices derived from Landsat-8 data. In-situ field data from 442 sites were used to validate the logistic regression and neural network models, to determine whether sites could be correctly classified as GDEs.”

and

“The 50% GDE probability map at Schedule F provides a reliable baseline for this water allocation plan and will be used to guide further targeted ground surveys during plan implementation.”

> Comment - This is a verification of the preliminary assessment but more on ground detailed investigations (particularly at high value GDEs and cultural assets) are urgently required prior to the plan being implemented for 10 years. Lots of the depth to groundwater mapping is based on model output and we don’t have the uncertainty for these depth to groundwater estimates. How much larger could the area of <15m depth to groundwater be under the predictive uncertainty analysis? Same question in this context as always.

Page 34 - “Stygofauna are likely to be present in alluvial, karstic and some fractured rock aquifers at depths of less than 100 mbgl (Hose et al. 2015).”

and

“Desaturation of suitable habitat is the biggest threat to stygofauna communities. Changes in water quality could also impact stygofauna. Where depth to groundwater is less than 50 metres there is increased probability of stygofauna occurring.”

> Comment - I agree with these statements so how do GDE impact criteria reflect this?

Page 34 - “Several springs occur in areas underlain by Dulcie Sandstone in the south-east part of the Central Plains water management zone. These spring sites are likely to have significant ecological values. More detailed assessment is needed to confirm the location of these springs and their potential connectivity with the regional groundwater resource.”

and

Page 35 - “The most significant is the Thring Swamp site associated with the Wycliffe Creek system, which supports an extensive area of GDEs and other wetlands and suitable habitat for several uncommon or highly restricted plant species as reported above.”

Comment - Given the obviously high biodiversity and cultural values of Thring Swamp it needs dedicated investigation asap. With such high ecological and cultural values this investigation should have happened in my opinion. Can the drawdown from the major projects reach this site under the range of uncertainty in model prediction? In what time frame in a worst-case scenario? Sensitivity and uncertainty analyses were extended in 2021 as previously noted but have never been made available to the CLC or used in the WAPs assessment of impact risk.

Page 35 - "Further work has been undertaken to extend the current methodology for GDE identification to the entire district, however it will take a number of years to complete thorough on-ground verification.

During the water extraction licensing assessment process the department identified that more explicit and updated guidance was required on how to assess the potential impact on GDEs"

Comment - This is the 4th iteration of the plan yet the on-ground investigations still aren't underway. Where are the GDE impact criteria for all 3 types of GDEs? I've only ever seen terrestrial presented, as previously noted I believe there are some issues therein. These should be presented in the allocation plan and supporting documents not left to the license application process.

Page 37 - 5.2. Considerations for protection of cultural uses

Comment - This section contains nothing specific on how the plan will do this. Given this is the 4th iteration of the WAP this should have already happened and there should be a timeline for how this is proposed to be addressed.

Page 38 - “Over 100 years the ESY represents a reduction of less than three percent of the natural water balance.”

> Comments - this is wrong it is close to 3% of storage which is very different, see comment at Page 30 - Figure 17 and table below. According to their water balance average annual net recharge is 58% of the ESY in the Central Plains Management Zone. A water balance is defined as “The flow of water in and out and changes in storage of a surface water system, groundwater system, catchment or specified area over a defined period of time.” according to the Australian Water Information Dictionary from the Australian Bureau of Meteorology.

Water Balance Verses ESY Table.

Area	ESY	ESY x 100	Recharge	EVT	Net Recharge	GW storage	ESY x 100 /Storage (%)	Net Recharge/ESY (%)
Davenport Ranges	4.4	440	16.1	2.6	13.5	7084	6.2	306.8
Central Plains	81.5	8150	96	49.1	46.9	137986	5.9	57.5
Southern Ranges	1.8	180	40.3	5.6	34.7	8651	2.1	1927.8
Total	87.7	8770	152.4	57.3	95.1	153721	5.7	108.4

Note this table was derived from:

1) Figure 17 (page 30) in the WAP background document, the water balance for recharge, evapotranspiration (EVT) and GW storage figures.

2) ESY is taken from Table 1 (page 11) in the draft WAP.

Blue columns are calculated with the calculation method shown in the table except for net recharge. net recharge = recharge - EVT.

Page 38 - “The ESY establishes the proportion of water from a water resource within the district that can be sustainably allocated for drinking water and for a range of commercial uses and reserved for future Aboriginal economic development.”

and

“The **estimated sustainable yield** means the amount of water that can be allocated from the water resource to support declared beneficial uses that is sustainable.”

> Comment - abstraction at twice average annual net recharge is by definition not sustainable.

Page 39 - “the Territory’s commitment to the Intergovernmental Agreement on a National Water Initiative 2014, which defines ‘environmentally sustainable level of extraction’ to mean ‘the level of water extraction from a particular system which, if exceeded would compromise key environmental assets, or ecosystem functions and the productive base of the resource’”

> Comment - I don’t think there is a high degree of confidence in the assessment that this level of allocation in the Central Plains management area will not “compromise key environmental assets, or ecosystem functions and the productive base of the resource”.

Page 39 - “That is, the majority of the water is retained in the environment to maintain important ecological functions and for cultural purposes and values of water in the region.”

> Comment - Only when compared to storage, abstraction proposed at almost twice net recharge will lead to widespread declining groundwater levels.

Page 40 - “The Western Davenport Ti Tree Water Advisory Committee advised that the recharge should be also be considered when determining the ESY.”

> Comment - It is unclear how recharge has been considered, storage is all this is quoted as the justification for ESY determination.

Page 40 - “Schedule G shows the modelled impact of 87,000 ML/year after continuous extraction of the ESY after 10 years and 50 years respectively.”

> Comment - What is the uncertainty in these predictions? If uncertainty analysis has been completed it needs to be presented.

NEW Draft WAP Mar 2023.pdf

Overall

From a scientific perspective most of what this document contains is a repeat of the background document.

Page 9 - “The **estimated sustainable yield** means the amount of water that can be allocated from the water resource to support declared beneficial uses that are sustainable.”

> Comment - note previous comment on this in the Background Document.

Page 9 - 3.2 Objectives of water sharing

> Comment - I would suggest that the following objectives are not being met in the context of the CLC’s interests: 3.2.1 (b), 3.2.1 (c), 3.2.2 (b) and 3.2.2 (c).

Page 13 - “**Limits of acceptable change** define measures of acceptable and appropriate water resource conditions that maintain desired outcomes for groundwater dependent ecosystems in the district.”

> Comment - Given the lack of uncertainty presented on drawdown predictions/depth to water table estimates from the modelling (critical controls on GDE impacts) and GDEs prioritised based on biological and cultural values it is unclear how the arbitrary 30% of GDE protection threshold meets limits of acceptable change.

DRAFT Implementation Actions MAR WAP.pdf

Overall

The risk assessment is highly subjective, I would have assigned higher residual risk ratings post the proposed management activities. The adaptive management frameworks are generic and, in many places, not specific enough. How were the risk assessments ratings determined? Internal DENR staff only? The WAP advisory committee? How will the huge amount of work proposed be funded? There are also issues with how the proposed actions are staged in terms of their order and completion dates.

Page 5 - "The risk assessment process ensures that water resources are allocated in a sustainable and resilient manner."

> Comment - A risk assessment is only as good as the understanding it is based on. Just because you have undertaken a qualitative risk assessment doesn't provide any surety that water resources are allocated in a sustainable and resilient manner.

Page 5 - "ensuring that water resources are available for future generations"

> Comment - Allowing nearly twice net recharge for allocation in the Central Plains Area will not ensure that water resources are available for future generations, this will deplete the resources.

Page 6 - "Combining risk management with adaptive management enables a proactive approach to managing risks"

> Comment - This is more of a retrospective approach and generally management/mitigation will only occur when and where problems occur. See my previous reviews and the Thommann et al. (2022) Paper. *Thomann, J.A., Werner, A.D. and Irvine, D.J., 2022. Developing adaptive management guidance for groundwater planning and development. Journal of Environmental Management, 322, p.116052.*

Page 6 - "The water monitoring program is critical to adaptive management and an overview of this program is provided in section 3."

and

Page 7 - 3. Water monitoring program

> Comment - I agree that a water monitoring program is critical to adaptive management. A monitoring plan should contain the exact locations, the frequency of water level and water quality monitoring. Some of this information is missing (how many measurements in discrete sites or the planned network expansion for GDE protection for example). I think the coverage of sites in Figure 3 is sparse and it is unclear how this will provide sufficient information on all 3 types of GDEs that are current poorly understood in terms of groundwater dependence and environmental water requirements (EWRs).

Page 7 - “monitor groundwater level trends and recharge”

and

“biannual site visits”

> Comment - Does this mean that the discrete monitoring sites will only be visited twice per year? It is nearly impossible to estimate recharge from 2 data points per year.

Page 7 - “Planned expansion of the monitoring network includes”

> Comment - The plan needs a commitment to what, where and when will be monitored. This is stated for some sites but not the areas proposed for the additional investigations to fill critical knowledge gaps.

Page 10+ - 4.1. Actions related to water requirements of key environmental values

> Comment - There are lots of management strategies and actions in these lists. I would question how feasible all of these are in the timeframes proposed and how much will all this cost? Does the DEPW have the staff and financial resources in place for this? Some of my biggest concerns are with items: 4.1.2, 4.1.3, 4.1.4, 4.1.5 which are expensive complicated projects in many cases in my experience that require long term (10+ years minimum) datasets that don’t exist and will not exist in their timeframes. Also, there are major issues with the timing of the projects as proposed, I’ll give some examples.

- 4.1.6 Define regional scale map of key environmental values associated with water including surface water springs.
    - Comment - This is proposed to be complete by 2033 but this is needed now otherwise how can they be protected/managed?
- 4.1.7 Releasing GDE health and monitoring guideline for use by both the department and licence holders to enable GDE condition to be assessed
    - Comment - This is proposed to be completed in 2023-2024 but lots of the studies required to produce this are proposed to be completed after this date.

Page 11 - 4.2. Actions related to water requirements of key Aboriginal and other cultural values

> Comment - These should have been completed for this plan, especially for critical sites like Thring Swamp. Also, baselines need to be obtained for some years prior to significant impacts occurring (there is substantial impact potential from Stage 1 of the Singleton project alone, hence why it has gone into an EPA EIS process) not in 2027.