Briefing Note

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Subject	**Boddington Gold Mine GGDVMMP Review Outcomes**

1.0 Introduction

Newmont Mining Corporation (Newmont) operates the Boddington Gold Mine (BGM), located approximately 17 km northwest of Boddington, Western Australia (WA). Newmont proposes to develop a second Residual Disposal Area (RDA2) to support tailings deposition. The footprint of RDA2 was approved by the WA Environmental Protection Authority (EPA) and the Australian Government Environmental Regulator in 2014. Under Condition 7 of the Ministerial Statement (MS) 971, a Groundwater and Groundwater Dependent Vegetation Monitoring and Management Plan (GGDVMMP) is required to be implemented for monitoring potential impacts to Groundwater Dependent Vegetation (GDV) health and abundance associated with groundwater drawdowns from operations activities. The current GGDVMMP (v.4) (Newmont Boddington Gold, 2021) was submitted and approved by the EPA in 2021.

Newmont engaged Umwelt Australia Pty Ltd (Umwelt) to review and update the GGDVMMP to support the Boddington LOM Extension Amendment Proposal, with the revised GGDVMMP intended to be submitted following referral as part of the Request for Information (RFI) process. Specifically, Umwelt was engaged to address:

- changes in project footprint associated with the LOM Extension
- alignment with latest EPA instructions for management plans and relevant legislation
- regulator and peer review comments regarding groundwater triggers, monitoring methods and vegetation monitoring results.

1.1 This Document

The purpose of this document is to summarise the findings of the GGDVMMP and data review, to provide recommendations regarding additional studies required or changes to the GGDVMMP for Newmont to consider. The document includes:

- review of changes to relevant guidelines (**Section 1.4**)
- summary of review findings and recommendations for management (**Sections 2.0** and **3.0**).
- summaries of the vegetation and groundwater context, including:
  - groundwater dependent vegetation extent (**Section 4.1.1**)
  - groundwater dependent vegetation monitoring (**Section 4.1.2**).
  - hydrogeological conditions (**Section 4.2.1**)
  - groundwater drawdown (**Section 4.2.2**)
  - potential GDV impacts from drawdown (**Section 4.2.3**)

Note that key recommendations are also emphasised in text, numbered according to the order they are presented in the summary of recommendations.

1.2 Changes to Guidelines

The EPA developed the *Instructions – Preparing Environmental Protection Act 1986 Part IV Environmental Management Plans* (Environmental Protection Authority, 2024), outlining the minimum requirements that the EPA needs to assess and approve. The instructions were revised in 2023, after the original GGDVMMP for BGM was approved in 2021. The key changes in the revision were:

- clearer distinction between outcomes and objectives,
- additional emphasis on outcomes-based management as the EPA's preference, where practical
- provision of updated templates and examples for EMPs.

The GGDVMMP was reviewed against the latest EPA (2024) *Instructions*; outcomes and actions are summarised in **Table 11**.

Table 1-1 Change to EPA guideline for preparation of EMPs and relevant actions

Section	Change	Actions
Document structure	Includes a template example outlining sections to be captured within the document.	Update GGDVMMP structure to follow the template. This has been partially completed.
Trigger Thresholds	Template outlines requirement to include details on timing and frequency of monitoring.	The GGDVMMP will be updated to include timing and frequency of monitoring.

2.0 Summary of Review Findings

A summary of the review findings is detailed below. Umwelt's recommendations to Newmont regarding changes to the GGDVMMP and management of GDV is detailed in **Section 3.0.**

2.1 Groundwater Dependent Vegetation

Current understanding of vegetation as it pertains to the identification and management of GDVs is as follows:

1. Exact locations of GDV, phreatophytic nature of vegetation and other factors which influence vegetation health are not well understood across BGM.
2. There are areas within the Plant Cell Density (PCD) extent not previously subject to vegetation mapping by Mattiske (2005 and 2012) and there is low confidence in the existing mapping.
3. Vegetation monitoring transects were established in Autumn 2022, however reassessment of the established transects was not conducted as outlined in the GGDVMMP. Areas of PCD decline noted in subsequent reports did not align with GDV transect locations.
4. To date, it has not been considered that BGM groundwater drawdown activities were responsible (fully or in part) to PCD loss and trigger criteria exceedances in potential GDV sensitive areas.
5. Significant changes in PCD occur in other disturbed areas, which is not reflective of potential influence from groundwater drawdown on the health and condition of native vegetation.
6. Recommendations have been made to apply a multispectral analysis height classification to the data to focus of trees and other potential GDV capable of potentially accessing groundwater.
7. Installation of the new RDA 2 will extend beyond current multispectral data acquisition extent. This will require a revision to expand the survey area and development of new baseline data.

2.2 Hydrogeology

Current understandings around hydrogeology as it pertains to the identification and management of GDVs are as follows:

1. At BGM four main groundwater systems (zones) exist. The Seasonal Shallow Groundwater Zone (SSGZ) forms the main groundwater zone within the rooting depth of plants however, deeper rooting vegetation has roots which extend into the underlying Weathered and Fractured Bedrock Zone (WFBZ) in select locations across the site; for example near the Hotham River.
2. Based on current available data, conceptualisation of geological and hydrological cross-sections across the site is limited. High spatial variability in thickness and connectivity of different groundwater zones across site limits the interpolation of hydrogeologic behaviour beyond point-source measurements at current monitoring bore locations.
   a. For example, the SSGZ is known to be comprised of isolated deposits of laterite gravels resulting in spatially disconnected perched groundwater systems in higher elevation areas. This strongly influences groundwater conditions in the shallow subsurface, limiting large scale spatial extrapolation from single point measurements when assessing shallow groundwater extent across site.
3. Due to uncertainties in available data and conceptual understanding, the precautionary principle should be applied when assessing areas with groundwater within 10 m of the topographic surface. Specifically, given identified error association with the accuracy of digital elevation models (DEMs), a depth to groundwater of 15 m is favoured to account for the increased uncertainty in depth to groundwater.
4. Analysis of current available data shows no evidence of drawdown in the SSGZ within the area of pit dewatering and depressurisation of groundwater levels in the underlying WFBZ. However:
   a. Available groundwater data for the SSGZ is currently spatially limited, particularly in areas mapped as potentially containing GDV outside mapped swamp areas.
   b. There is the potential for natural connection between the SSGZ and WFBZ through the oxide, or an artificial connection caused by ungrouted abandoned drillholes in these locations (Big Dog Hydrogeology, 2025).
5. Periods of groundwater level decline have been recorded in the SSGZ (in addition to underlying WFBZ and DFBZ) associated with groundwater extraction at Westwood Borefield production bores in areas mapped as potential GDVs. Noting however there have been no significant declines in PCD attributed to recorded declines in water level associated with groundwater extraction in adjacent GDV.
6. Groundwater trigger/threshold criterion in the current GGDVMMP are being applied to bores screened in both the SSGZ and underlying WFBZ due to inconsistencies in information provided by Tables 2 and Table 3 of the GGDVMMP.
   a. Assessment of groundwater trigger/threshold criterion from monitoring should corollate with several areas of potential severe impacts to vegetation. However, no associated impacts are observed in the vegetation PCD data. As a result, the recommendation by Big Dog Hydrology to significantly change how groundwater levels are utilised as a trigger/threshold criterion in the GGDVMMP is supported.

3.0 Recommendations

In addition to recommendations provided by Big Dog Hydrogeology (2022, 2025), BGM should consider the following recommendations, as outlined in **Table 3-1**, to improve monitoring of potential impacts to GDV from groundwater drawdown. These recommendations are in broad sequential order in which they would logically be undertaken, and further background and justification on recommendations is provided in **Section 4.0**.

Table 3-1 Recommendations and Rationale

	Recommendation	Rationale
1	Update terrain DEM across site.	Provides a more accurate topographic surface elevation to inform other studies, limits the need for application of buffers, provides greater certainty in potential GDV mapping areas and depth to groundwater.
2	Update the site numerical groundwater model to include all activities to date, and future planned activities at site and surrounding activities.	Enables a more targeted monitoring approach and builds confidence in detecting potential impacts for approved and foreseeable mining.
3	Targeted field work to inform the extent and thickness of the oxide zone/aquitard. Potentially using non-intrusive geophysical survey and targeted drill/bore locations to verify results.	To provide more targeted data to define areas where groundwater is likely in the shallow subsurface (<10 mBGL), to distinguish areas with permanent/semi-permanent groundwater in the SSGZ from areas which are predominantly dry and only occasionally saturate, and to demonstrate low risk of impact to GD's where possible.
4	Undertake revised and complete GDV mapping.	To provide greater certainty around GDV locations, and inform appropriate transect monitoring locations to meet objectives of conditioning to prevent impact to GDV.
5	Apply a height classification to the PCD multispectral analysis data, assessing changes in PCD for vegetation associated with the canopy layer only.	To remove frequent large changes in PCD occurring in the agricultural zone and other disturbed areas, which is not reflective of potential influence of groundwater drawdown on the health and condition of native vegetation.
6	Review PCD data to identify optimal location/s and number of vegetation monitoring transects required to cover mapped potential GDV areas.	Aligning GDV transects with available PCD data to date will allow for more robust comparisons between the two-vegetation datasets where declines in PCD occur. This should include revision to the survey area and development of new baseline data for the new RDA2.
7	Installation of additional bores in selected key mapped GDV locations.	To provide sufficient spatial coverage to investigate any vegetation trigger exceedances and potential link to mine groundwater drawdown.

	Recommendation	Rationale
8	Revise GGDVMMP approach to use static groundwater level trigger/threshold criteria.	Big Dog Hydrology (2022, 2025) has shown that the current groundwater trigger and threshold criteria approach is not appropriate at BGM.

Completion of these recommendations will also assist with continued compliance of reporting requirements under the EPA guidelines as per the GGDVMMP.

Appendix B, Table B.1 provides a copy of the relevant sections from (1) the DWER Compliance Audit Report (Department of Water and Environmental Regulation, 2022) and (2) Newmont's response to Ministerial Statement 971 Compliance Audit (Newmont Boddington Gold, 2022), along with Umwelts current response/actions.

4.0 Vegetation and Groundwater Context

This section provides further contextual detail of Umwelt's review to support the summarised findings listed in **Section 2.0** above including:

- Extent of mapped GDV,
- GDV monitoring,
- Supporting hydrological conditions,
- Extent of groundwater drawdown, and
- Potential or observed impacts to GDV from operations (including current GDV health monitoring approaches and recorded declines in PCD.

4.1 Vegetation

4.1.1 Groundwater Dependent Vegetation Extent

The GGDVMMP broadly defines GDV as areas containing a combination of:

- Potential GDV vegetation types (VTs) (as assessed and defined from descriptions of dominant taxa of mapped VTs by Mattiske Consulting Pty Ltd over a large portion of the multispectral data capture extent) and,
- An estimation of the extent of baseline (pre-mining) depth to groundwater within 10 m of the ground surface (as at baseline 2006).

However, the GGDVMMP applies a more conservative and precautionary approach when defining the extent of potential GDV locations, using a deeper estimated depth to groundwater of 15 m. This is due to:

- uncertainties and assumptions around the baseline depth of groundwater from the topographical surface, and conceptualisation of hydrogeology (Big Dog Hydrogeology, 2018)
- variation in the Digital Elevation Model data available

- low confidence in the accuracy of vegetation mapping, and gaps in vegetation mapping over some portions of the monitored area
- uncertainties around the phreatophytic nature of GDV, and lack of understanding of factors at the site that may influence vegetation health (Umwelt, 2024)
- absence of detailed ground truth site data (Newmont Boddington Gold, 2021).

RECOMMENDATION #1: Update terrain digital elevation models (DEM).

RECOMMENDATION #4: Undertake revised and complete GDV mapping.

The current GGDVMMP contains outcome-based provisions around groundwater level and vegetation health criteria for management of impacts to GDV. Reviews of the current understanding of vegetation health (measured as PCD) and groundwater levels (groundwater drawdown) as they pertain to management of potential GDV locations are presented in **Section 4.1.2** and **4.2.2** respectively.

4.1.2 Groundwater Dependent Vegetation Monitoring

Under the current GGDVMMP, monitoring of GDV health is undertaken through a variety of techniques, including:

1. PCD analysis (broad-scale assessment across the site) followed by targeted investigations to identify causal factors for recorded declines in PCD such as groundwater drawdown.
2. Transect based field monitoring of health and abundance of GDV followed by target investigations to identify causal factors for recorded declines in Canopy Condition Ranking or GDV abundance.
3. Sap flow meter, Leaf Water Potential assessment or similar methods of targeted surveys if water stress is identified as a potential causal factor for declines during the above vegetation analyses.

Since the current GGDVMMP came into effect PCD Analysis has been conducted on an annual basis (bi-annual in 2021 and 2022). A summary of outcomes from this analysis are outlined in **Section 4.1.2.1** and **4.1.2.2**.

Targeted vegetation monitoring transects were established in Autumn 2022 (Umwelt, 2024). However, reassessment of the established transects was not carried out. Areas of PCD decline noted in subsequent reports did not align with GDV transect locations. It was recommended by Umwelt (2024) that depending upon the results of subsequent PCD multispectral assessment, further GDV monitoring transects should be established, particularly in any native vegetation areas subject to PCD decline. Aligning GDV transects with available PCD data to date will allow for more robust comparisons between the two-vegetation datasets where declines in PCD occur.

Recommendation #6: Review PCD data to identify optimal location/s and number of vegetation monitoring transects required to cover mapped potential GDV areas.

4.1.2.1 Plant Cell Density (PCD) Analysis

Plant Cell Density (PCD) is a measure of the ratio of infrared and red bands and is known to correlate with the vigour and reflectance of vegetation, with a high PCD value representing high, healthy leaf density. At BGM, loss of mean PCD (PCD decline) is used as a measure for vegetation health impacts with a decline of >10% (annually and since baseline) constituting a Trigger Criteria exceedance as per Table 2 of the GGDVMMP (Newmont Boddington Gold, 2021).

PCD is measured using multispectral data acquired on an annual basis across and beyond the extent of mining operations. A grid series of 1 ha polygon units ('PCD Blocks') is prepared across the extent of multispectral data acquisition. Changes in PCD are measured over an annual assessment period covering autumn – autumn (trigger criteria data) and an assessment since baseline covering autumn (current year) – autumn (2019). Changes are classified into several categories. Data capture has mainly focused on autumn, being the period of the highest vegetation stress with reference to reduced available soil water.

In addition to the requirements under the GGDVMMP, PCD analysis is also included in the list of Trigger/Threshold criteria under the current RDA GMP (Big Dog Hydrogeology, 2024). Changes to the Mine impact footprint with the installation of the new RDA 2 will extend beyond the extent of current multispectral data acquisition and require a revision to the survey area and development of new baseline data for the additional survey area **[Recommendation #6]**. RDA 2 is outside of the Scenario 2 drawdown impact area and thus not covered under GGDVMMP vegetation monitoring extent. However, PCD monitoring and vegetation reporting are also listed as requirements under the RDA GMP with declines in PCD of >20% constituting a Trigger exceedance under Section 5.4 of the RDA GMP (Big Dog Hydrogeology, 2024).

4.1.2.2 PCD declines

Since PCD monitoring commenced, declines in PCD of >10% have been recorded in areas mapped as potential GDV. However, total areas of PCD decline for both annual assessment and change since baseline have continued to be much lower in comparison to PCD gains across site (both in terms of the total area, and within potential GDV areas). Most of the assessed area (total area and potential GDV extent) has consistently been represented by either no significant change in PCD, or insufficient vegetation cover (Umwelt, 2023a, 2023e, 2024).

To date, it has not been considered that BGM groundwater drawdown activities were responsible (fully or in part) to PCD loss resulting from trigger criteria exceedances in potential GDV sensitive areas. Declines in PCD have been attributable to other activities, actions or environmental factors including:

1. Cleared agricultural land containing non-native vegetation (pasture) remnant trees over pasture.
2. Approved clearing and rehabilitation works.
3. Infrastructure, including roads/tracks, RDAs, etc.
4. *Phytopthora* dieback infestations (both known/mapped locations and 'Uninterpretable').

Impacts to PCD have been observed adjacent to cleared agricultural land, which includes blocks which partially overlay native riparian vegetation, associated with the Hotham River containing areas of pasture. This decline in PCD has been attributed to the wider expression of decline of PCD associated with pasture.

Applying a multispectral analysis height classification to the data will assist in (i) the determination of the level of impact on changes in the health of introduced pasture/paddocks may be having on the PCD dataset (Umwelt, 2023d), and (ii) focusing the analysis on vegetation types that are more likely to be GDV (i.e. taller tree's with deeper roots).

Recommendation #5: Application of a multispectral analysis height classification to the data, where changes in PCD for vegetation associated with the canopy layer only is additionally provided.

In Autumn 2023, there was increased spatial area of PCD decline within several potential GDV areas including Boggy Brook North, House Brook, 34 Mile Brook South and Mundalup. This was found to be due to a combination of non–groundwater related factors (including mine-related clearing and ongoing effects of *Phytopthora* dieback infestations). However, it was noted that impacts due to declining groundwater levels cannot be ruled out, particularly at Mundalup / 34 South Mile Brook (where deeper groundwater bores have shown a steady decline in groundwater levels) due to a lack of appropriate shallow groundwater monitoring locations (Umwelt, 2024).

No shallow groundwater monitoring bore screened within the SSGZ exist in the Mundalup GDV area which limits causal factors comparisons of PCD declines with groundwater levels. The only groundwater bore recording groundwater drawdown in potentially affected areas within 10 m of the topographical surface is that associated with Wattle Brook (WD7BR4). Wattle Brook has recorded several areas of PCD decline (<20%), however clearing associated with mining activities appears to be a primary driver of decline (Umwelt, 2024).

It is noted that there are no monitoring bores within the North RDA potential GDV area analysed as part of the PCD analysis. To date no PCD decline was recorded in this potential GDV area within the Scenario 2 drawdown extent, however any future potential declines in PCD lack a baseline groundwater comparison (Umwelt, 2024).

4.2 Groundwater

The following is a review of available Big Dog Hydrogeology reports since 2021, for the purpose of providing recommendations on the monitoring and management approaches in the GGDVMMP. This is not intended to be an exhaustive hydrogeological review, as Big Dog Hydrogeology has completely a significantly more in-depth assessment of groundwater on site.

4.2.1 Hydrogeological Conditions

At BGM there are four main groundwater systems (zones) present. These zones display high spatial variability in thickness across site and play an important role in controlling both vertical and lateral movement of water across site.

- Seasonal Shallow Groundwater Zone (SSGZ) comprises a discontinuous groundwater system occurring as isolated lenses rather than as a continuous layer through near-surface accumulation of gravels, sands and hardcap. This zone is typically 3-5 m thick, however has been recorded in excess of 10 m thickness (Newmont Boddington Gold, 2021).

- Oxide Zone, comprised mainly of highly weathered bedrock material (massive clay oxide), located beneath the SSGZ and above the interface with the Weathered and Fractured Bedrock Zone (WFBZ). Where present, the layer generally acts as a barrier to slow the transmission of groundwater to layers below. However, some hydraulic connection through the oxide is known to occur and it is absent in some areas, particularly in areas near Hotham River to the south of site (Big Dog Hydrogeology, 2018; Golder, 2019). For further details refer to Supplementary Materials Section 1 in the GGDVMMP (Newmont Boddington Gold, 2021) for list of several possible flow pathways. The depth to the top of the oxide unit from the topographical surface ranges from 0 m to 54 m, and the thickness of the oxide unit can range from 0 m to 100 m.
- WFBZ is the major regional groundwater system at Boddington and is the most extensive groundwater system on site. Most of the monitoring bores are screened in this zone. Groundwater surface water connections occur between the WFBZ (and potentially the Deep Fractured Bedrock Zone (DFBZ)) and Hotham river and its tributaries, with groundwater flows into the Hotham River, at least during the drier part of the year (Big Dog Hydrogeology, 2018; Golder, 2019). The average thickness of the zone is 7 m (ranging from 0 m to 24 m), with depths from surface highly variable (13 m to 100 m) (Newmont Boddington Gold, 2021). Hydrographs for the WFBZ indicate rainfall recharge response where the Oxide Zone is thin or absent. Groundwater discharge from the WFBZ occurs via downward flow to the underlying DFBZ and potential baseflow contributions where the unit is incised near creeks including the Hotham River.
- Deep Fractured Bedrock Zone (DFBZ), located in the basement rocks of the two regional geologies on site (regional greenstone unit and granitoides with dolerite dyke intrusions). The zone consists of open fracturing occurring at depths of 100 mBGL to 200 mBGL in the bedrock. The groundwater transmission on a local basis is controlled by the intensity and openness of the fracture zones present (Big Dog Hydrogeology, 2018). The DFBZ is intersected within the open cut pits and is the water source targeted by the Westwood Borefield. Hydrographs for the DFBZ (i.e. HRVWP01) indicate a more subdued rainfall recharge response compared to the weathered zone. Where data is available from the VWPs, groundwater levels in at WFBZ and DFBZ follow similar trends, indicating a degree of hydraulic connection. However, the DFBZ shows a much more pronounced response to drawdown from the Westwood Borefield, with only minor drawdown observed in the WFBZ.

Mining influences on groundwater occur in three areas at BGM and are managed under a combination of the RDA Groundwater Management plan (RDA GMP) (Big Dog Hydrogeology, 2024) and GGDVMMP:

1. Groundwater mounding around existing RDAs (covered under RDA GMP). The existing and future residual disposal areas (RDA) involves disposal of tailings material as a slurry mix with water. The water content of the disposal material can result in localised mounding around the RDA's that increased the water table within the shallow aquifer (SSGZ and Oxide Zone) and can change water quality.
2. Dewatering around the open pits (covered under GGDVMMP), with the open cut mine operations that intersect the DFBZ resulting in depressurisation of the DFBZ aquifer and connected aquifers.
3. Localised drawdown around Westwood production Borefield (covered under GGDVMMP), which targets the DFBZ and results in localised drawdown in the DFBZ and connected aquifers around the active bores.

Cumulative impacts associated with the combination of site activities and surrounding mining have not been modelled or assessed. Qualitative review by Big Dog Hydrogeology (2025) indicated no significant overlaps in groundwater impacts between the various mine activities. As such the current management of groundwater mounding and groundwater decline is managed separately under the RDA GMP (for groundwater mounding) and GGDVMMP (for groundwater decline).

4.2.2 Groundwater Drawdown

This section presents a summary of the hydrogeological conditions at BGM and potential for impacts to GDV from impacts associated with groundwater drawdown as part of NBG mining operations as previously reported. All information presented is based on existing reporting and assessment conducted for the site.

Groundwater drawdown is occurring at BGM as part of approved mine operations. Current activities linked to groundwater drawdown at BGM include dewatering of mine pits and abstraction of groundwater from the Westwood Borefield. Drawdown has the potential to affect vegetation health in particular groundwater dependent vegetation (GDV) and riparian vegetation along Hotham River and its tributaries (Strategen Environmental Consultants, 2013).

4.2.2.1 Current Groundwater Drawdown Extent

Pit Dewatering

Since pumping from pit lakes commenced in 2007, the WFBZ and DFBZ aquifers have depressurised due a combination of (1) pumping out pit lakes and (2) continuous dewatering during mining. Where significant drawdown associated with pit dewatering has occurred, several WFBZ bores have gone dry.

A regional numerical groundwater flow model for site was completed by Golder in 2019, which included modelling of predicted groundwater drawdown associated with pit dewatering (Golder, 2019). There are limited modelling results available to verify if the predicted groundwater level changes align with observed groundwater levels over time.

Available information indicates the actual rate of open pit dewatering to 2025 appears to be comparable to the rates predicted by the groundwater model. Evaluation of the monitoring data found within the Scenario 1 modelled drawdown extent for 2026 had a relatively good fit to the interpolated observed extent in 2025. Scenario 2 predictions were seen as greatly overestimating the drawdown extent, with no drawdown observed in bores outside of Scenario 1 extent (Big Dog Hydrogeology, 2025).

As of 2021, total drawdown measures in monitoring bores in the WFBZ and DFBZ since dewatering commenced was in the range 5 m to 13 m (Big Dog Hydrogeology, 2021).

Westwood Borefield

For monitoring bores near the Westwood Borefield which are screened in the SSGZ and in the WFBZ, groundwater depths are less than 20 mBGL. As such, there is potential for interactions between groundwater and the root zone of vegetation including GDVs (Big Dog Hydrogeology, 2025).

Groundwater extraction from the Westwood Borefield production bores targets primarily the DFBZ. Operation of the Westwood Borefield drawing up to 50 L/s from the DFBZ has caused drawdown of up to 200 m to occur within the DFBZ (Big Dog Hydrogeology, 2025). Drawdown in the overlying WFBZ has been up to a maximum of 10 m, with drawdown of around 5 m noted in the SSGZ (bore HFBR1D) during Westwood Borefield operations in 2021. Groundwater levels have since recovered to pre-abstraction levels once pumping ceased.

Drawdown in the SSGZ and WFBZ is sufficient to present a risk potential risk to GDV in the vicinity of drawdown. Also, as discussed in **Section 4.2**, Hotham River and its tributaries receive baseflow contributions from the WFBZ and potentially the DFBZ, particularly during the drier part of the year. Therefore, the drawdown has the potential to change baseflow contributions to Hotham River and its tributaries. However, no impacts to Hotham River have been observed based on currently available data.

4.2.3 Potential GDV Impacts from Drawdown

Under the current GGDVMMP (Newmont Boddington Gold, 2021), interpretations of groundwater triggers and threshold criteria by Big Dog Hydrogeology indicate that the rates and magnitude of drawdown around the pit and Westwood Borefield could potentially pose severe risk to GDV (based on Chart 1 and Chart 2) (Big Dog Hydrogeology, 2022). A table of calculated risks to potential GDV associated with changes in groundwater levels is outlined in **Appendix A**, as required in the DWER Compliance Report.

During Big Dog Hydrogeology's review of groundwater levels against Chart 1 and Chart 2 of the GGDVMMP, multiple issues with the application of the charts were noted with recommendation to change trigger/threshold criteria. Details on the application of Chart 1 and Chart 2 from Freond and Loomes are detailed below, with a brief summary of recommendations regarding changes to trigger/threshold criteria.

According to analysis by Big Dog Hydrogeology (2022) several bores exceeded trigger and threshold criteria (**Table A.1**). This included seven bores in the WFBZ, two in the SSGZ and one with the groundwater zone unknown. It is worth noting that in the application of Chart 1 in the GGDVMMP to groundwater level change as it pertains to Trigger and Threshold criteria was applied to all bores listed in the management plan (as per Table in the GGDVMMP) across the four main groundwater systems (zones) present on site. However, groundwater provisions outlined in Table 2 in the GGDVMMP states that trigger and threshold criteria only apply to groundwater levels in the SSGZ at predicted GDV sensitive locations. Of the two bores located in the SSGZ, RNSWPZ3b only recorded a trigger exceedance during the Q1 period, with changes in groundwater level below trigger levels for the remainder of the year. Bore HFBR5S is located near Westwood Borefield and is influenced by groundwater extraction from production bores.

Analysis of risk rankings presented Chart 1 in the GGDVMMP to the magnitude of Westwood Borefield drawdown (up to 15 m) and the rate of drawdown (more than 5 m/year) suggests that groundwater extraction could potentially pose a severe risk to vegetation dependent on either the SSGZ or the WFBZ if pumping were to continue for significant periods. Groundwater elevations near Hotham River (and associated riparian vegetation) from VWPs HRVWP01, and HRVWP02 and adjacent standpipe monitoring bores continue to reflect baseline seasonal recharge and discharge patterns across all zones, with no open pit dewatering or production bore operation impacts evident (Big Dog Hydrogeology, 2021).

Drawdown associated with Westwood Borefield operations have been localised to within 1km of the borefield (based on data from 2015 to 2020). However, it is expected that if operations continue at the maximum allowed abstractions rates, this will cause drawdown to eventually be observed in HFVWP01, HFVWP02 and adjacent standpipe monitoring bores (Big Dog Hydrogeology, 2021) with potential impacts to Hotham River and associated riparian vegetation. Big Dog Hydrogeology (2022) recommends that monitoring and management of the Westwood Borefield is therefore a key component for the updated GGDVMMP.

Within the Scenario 1 drawdown model extent, analysis of current available data records over the 17-year period of pit dewatering shows no evidence of vegetation impairment due to groundwater drawdown in the WFBZ. This analysis is primarily based on data from the monitoring bores at Round, Pillow, and Boomerang Swamp, Big Dog Hydrogeology (2022, 2025) noting that data within the Scenario 1 drawdown in the SSGZ outside of these select locations is very limited. Where data is available, drawdown in the WFBZ has not been shown to cause drawdown in the SSGZ within the cone of depressurisation surrounding the pit. Big Dog Hydrogeology (2025) reports that this may be due to the presence of the oxide unit situated between the SSGZ and WFBZ, which acts as an aquitard where present. Due to the presence of the aquitard, Big Dog Hydrogeology (2025) reports that pit dewatering impacts on groundwater levels pose a low risk to overlying vegetation and potential GDV in the area. However, where noted localised hydraulic connection is present or the oxide unit/aquitard is absent, there is potential for hydraulic connection to the SSGZ and potential impacts. Other connections such as ungrouted abandoned drillholes can also form potential pathways for drawdown (Big Dog Hydrogeology, 2025). Umwelt also recommend further verification of the extent and thickness of the oxide zone/aquitard at key locations and installation of shallow monitoring bores. This will help verify assumptions regarding potential impact pathways and could be utilised to inform any potential updates to the groundwater model in future.

RECOMMENDATION #3: Fieldwork to determine extent and thickness of the oxide zone/aquitard near key GDVs[1].

This information would assist with confirming the absence of a potential impact pathway and potentially reduce the monitoring to areas that are more relevant and better able to demonstrate compliance.

RECOMMENDATION #7: Installation of additional nested groundwater monitoring bores targeting the SSGZ and underlying WFBZ.

Additional bores at selected locations would increase understanding of the potential for connectivity between the two groundwater zones and assist with connecting (or discounting) potential impacts from operations to area of GDV and the Hotham River. Some suggested locations include:

1. Installation of a deep bore into the DFBZ and a shallow bore in the SSGZ near WD7BR4.WD7BR4 is within expected drawdown extent, within a mapped GDV, is 38 m deep in WFBZ and the hydrograph shows seasonality.

   This set of bores will then:

   i. provide data on the groundwater level response and connectivity between aquifers to address data gaps on ecohydrological conditions to the south of site;

[1] this will likely require the collection of additional information to create a more detailed understanding of the shallow sub-surface stratigraphy and hydrogeology. Potentially using geophysical survey methods.

ii. establish further baseline data to confirm groundwater interactions at a potential GDV location to the south of site (currently monitoring only covers swamps to the north), and

iii. provide a nested groundwater early warning (in the DFBZ and WFBZ) and first trigger (in the SSGZ) site.

2. Establish paired bores and stream gauge/s locations relevant for potential riparian GDVs to compare surface water and groundwater levels and identify time periods of groundwater contributions to surface water (gaining stream) and potential periods of surface water contributions to groundwater (loosing stream). This could also provide a warning indicator of potential impacts to riparian GDV, particularly during periods of groundwater abstraction from Westwood Borefield production bores.

In addition to drawdown impacts, there is also the potential for impacts to all vegetation, including potential impacts to GDV associated with seepage from the RDAs. Impacts to vegetation from RDA seepage are covered under the RDA GMP (Big Dog Hydrogeology, 2024) and are not included in the GGVMMP.

4.2.3.1 Changes to Groundwater as a Trigger

Recent groundwater reviews by Big Dog Hydrogeology (Big Dog Hydrogeology, 2022, 2025) have recommend several changes to the GGDVMMP including the way in which groundwater is used as a trigger for impacts to GDV.

Big Dog Hydrogeology (2025) recommended that groundwater triggers for existing dry shallow bores be removed from the GGDVMMP. Instead, vegetation monitoring should be routinely included in the GGDVMMP as a primary trigger within the current impact area. The monitoring of groundwater within this area should continue (as per bore locations and times in current GGVMMP plan) and be expanded to include new monitoring bore locations in key potential GDV monitoring locations (Big Dog Hydrogeology 2022, 2025). Groundwater monitoring data is recommended by Big Dog Hydrogeology to be used in trigger investigations, once selected vegetation trigger/s have been exceeded, to identify the cause of any impairments and if they are likely to be attributed to mining related impacts (Big Dog Hydrogeology, 2025). Umwelt proposes the use of the deeper bores to verify that the observed groundwater trends within the deeper WFBZ and DFBZ match predicted response under Scenario 1 impacts and to provide an early indication of impacts exceeding current predictions. To enable a more targeted monitoring approach and builds confidence in detecting potential impacts for approved and foreseeable mining the groundwater model should be updates to reflect all current available data with expected drawdown extents over time for each standpipe monitoring bore explicitly stated.

Recommendation #2: Update numerical model to account for any potential cumulative impacts from surrounding operations, to provide trigger levels representative of future groundwater conditions.

Outside of the current impact area Big Dog Hydrogeology (2025) recommended that static groundwater triggers should be applied to current (not currently experiencing groundwater drawdown) and future bores listed in the GGDVMMP. The current Chart 1 and Chart 2 from Froend and Loomes approach for determining trigger/threshold criteria and exceedance is to be removed from the GGDVMMP. The application of static triggers is practical, easily monitored for impacts (and trigger exceedances) and can be monitored over short temporal scales for potential groundwater drawdown.

Recommendation #8: Revise GGDVMMP approach to use static groundwater level trigger/threshold criteria.

In accordance with recommendations from Big Dog Hydrology (2022, 2025) regarding groundwater trigger and threshold criteria and to address the DWER audit comment 971:M7:3 and allow for ease of continued compliance with reporting requirements, Umwelt proposed to further develop and potentially apply the following groundwater level trigger/threshold criteria in the GGDVMMP.

Groundwater levels as trigger and threshold criteria will be applied differently for bores within Scenario 1 predicted impact extent compared to bores outside Scenario 1 predicted impact extent.

a. For bores within Scenario 1 (2032) with static triggers, groundwater levels remain at or above Scenario 1 predicted levels for individual bores, with early indication of predicted change in levels (in line with predicted impacts) based on baseline limits for individual bore.
b. For bores outside Scenario 1 predicted impact extent, groundwater levels are to remain within baseline limits for individual bore. Here groundwater level decline beyond normal seasonal fluctuation can be used as a useful primary trigger or threshold for potential impacts for GDV.

The specific trigger and threshold criteria proposed by Umwelt are detailed in **Table 4-1.**

Table 4-1 New proposed Trigger and Threshold Criteria

Bore Location	Trigger Criteria	Threshold Criteria
Bores within Scenario 1 predicted impact extent	One groundwater level reading below the trigger criteria/baseline limit will initiate review of observed groundwater levels to Scenario 1 predictions.	Groundwater level trends show greater drawdown compared to Scenario 1 predicted levels, will constitute a threshold exceedance.
Bores outside Scenario 1 predicted impact extent	One groundwater level reading below the trigger criteria/baseline limit will initiate internal investigation into the results	Two consecutive groundwater level readings below the trigger criteria/baseline limit will constitute a threshold exceedance.

5.0 Conclusion

During the review of contextual information and the GGDVMMP, it was identified that there are data deficiencies that limit the ability to properly monitor potential impacts on GDV from groundwater drawdown at BGM and demonstrate compliance with Ministerial conditions.

Actions to address data deficiencies have been recommended for Newmont to consider, which will inform the approach for the revision of the GGDVMMP. The actions include undertaking additional hydrogeological studies, revising GDV mapping, replacement of new vegetation monitoring transects, installation of additional monitoring bores in targeted locations, and refining PCD analysis to focus on canopy data.

Collectively, these actions will provide more comprehensive and accurate contextual information, thereby allowing a more robust monitoring program to be outlined in the GGDVMMP that will address relevant audit comments from DWER as outlined in this summary. If the recommended actions are implemented, the revised GGDVMMP and monitoring will provide Newmont and the regulator with more confidence that potential impacts on GDV from groundwater drawdown can be detected and will facilitate ongoing compliance with ministerial conditions. Additionally, in future the data may provide Newmont with evidence to demonstrate the areas where there is a very low risk that groundwater drawdown at BDM will impact GDV. This might justify further refining the GGDVMMP to provide greater certainty in the management approach to mitigate the risk of non-compliance and resulting impacts to mining operations.

Recommendations are designed to address current gaps in available site data, which to date have limited the potential for changes to be made to the area monitored under the GGDVMMP, in particular;

1. The collection of more site-specific information to refine shallow groundwater (>10 m) mapping along with hydrogeologic stratigraphy underpinning shallow groundwater locations and connectivity to underlying aquifers across site, and
2. Better refined estimations of potential GDV locations allowing for more targeted vegetation monitoring in areas of concern.

Without this additional information, the ability to convince the regulator to accepted modifications to the GGDVMMP will be limited and may pose risks to water supply for the expansion of the mine and or potential compliance reporting.

6.0 References

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Appendix A

NBG application of Chart 1

Appendix Table A.1 NBG application of Chart 1 (Big Dog Hydrogeology, 2022

Bore	Ten Year Average	2020				2021				Drawdown from 10 year average (m)				Change from 2020 to 2021 (m/yr)			
	mBGL	mBGL	mBGL	mBGL	mBGL	mBGL	mBGL	mBGL	mBGL								
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
BMSWPZ1A	3.05	4.19	4.49	2.52	2.23	3.31	2.86	1.68	2.12	0.26	-0.19	-1.37	-0.93	-0.88	-1.63	-0.84	-0.11
HBBR2	13.66	13.19	13.26	13.29	12.18	13.44	13.4	11.75	12.92	-0.22	-0.26	-1.91	-0.74	0.25	0.14	-1.54	0.74
HFBR5S	3.87	3.06	5.22	5.22	5.12	5.26	5.23	5.31	2.18	1.39	1.36	1.44	-1.69	2.20	0.01	0.09	-2.94
N4921-1A	14.32	15.71	15.9	16	16.08	16.11	16.38	17.73	15.51	1.79	2.06	3.41	1.19	0.40	0.48	1.73	-0.57
PISWPZ3A	21.53	22.7	22.69	22.68	22.65	21.61	21.12	22.62	22.61	0.08	-0.41	1.09	1.08	-1.09	-1.57	-0.06	-0.04
RNSWPZ3B	3.59	3.59	3.8	2.66	3.67	3.74	3.8	2.87	3.59	0.15	0.21	-0.72	0.00	0.15	0.00	0.21	-0.08
BMSWPZ1B	2.03	3.27	3.38	1.28	1.69	2.44	1.94	1.38	1.54	0.41	-0.09	-0.65	-0.49	-0.83	-1.44	0.10	-0.15
HRBR1D	6.51	6.99	7.25	6.34	6.27	6.95	6.88	5.59	5.74	0.44	0.37	-0.92	-0.77	-0.04	-0.37	-0.75	-0.53
HFBR5D	5.16	2.53	5.7	7.35	6.87	7.32	10.77	8.68	2.1	2.16	5.61	3.52	-3.06	4.79	5.07	1.33	-4.77
N5005-1A	11.62	11.23	11.23	11.27	11.21	11.28	11.22	11.24	11.21	-0.34	-0.40	-0.38	-0.41	0.05	-0.01	-0.03	0
RNSWPZ1	3.17	3.43	3.42	3.42	3.42	3.42	3.43	2.3	3.36	0.25	0.26	-0.87	0.19	-0.01	0.01	-1.12	-0.06
WD7BR4	4.82	4.65	6.1	5.32	4.32	4.8	6.08	5.17	3.81	-0.02	1.26	0.35	-1.01	0.15	-0.02	-0.15	-0.51
BMSWPZ2	4.55	4.61	4.71	4.62	4.64	4.55	4.62	4.63	4.66	0.00	0.07	0.08	0.11	-0.06	-0.09	0.01	0.02
HRBR1S	6.58	7.02	7.27	6.42	6.33	6.98	6.93	5.82	5.78	0.40	0.35	-0.76	-0.80	-0.04	-0.34	-0.60	-0.55
HFBR8S	6.05	5.84	6.37	5.95	5.66	6.05	6.12	5.24	4.02	0.00	0.07	-0.81	-2.03	0.21	-0.25	-0.71	-1.64
PISWPZ1	2.96	3.72	3.72	3.72	3.71	3.7	3.64	2.67	3.14	0.74	0.68	-0.29	0.18	-0.02	-0.08	-1.05	-0.57
RNSWPZ2	3.41	2.52	2.18	2.18	2.18	2.52	2.62	2.37	2.48	-0.89	-0.79	-1.04	-0.93	0.00	0.44	0.19	0.3
WTBR1	14.08	15.78	15.87	15.93	15.97	16.13	16.3	16.25	16.27	2.05	2.22	2.17	2.19	0.35	0.43	0.32	0.3
HBBR1	40.26	40.71	40.72	40.77	40.81	40.82	40.86	40.88	40.97	0.56	0.60	0.62	0.71	0.11	0.14	0.11	0.16
HFBR8D	5.69	5.79	6.32	5.85	5.58	6.01	6.05	5.18	4.05	0.32	0.36	-0.51	-1.64	0.22	-0.27	-0.67	-1.53
MUBR3	14.34	15.45	15.63	15.59	15.7	15.79	15.87	15.95	16.04	1.45	1.53	1.61	1.70	0.34	0.24	0.36	0.34
PISWPZ2	3.06	2.98	2.95	2.97	2.94	2.93	2.93	1.83	2.56	-0.13	-0.13	-1.23	-0.50	-0.05	-0.02	-1.14	-0.38
RNSWPZ3A	14.78	15.35	16.05	15.7	15.28	16.1	16.1	15.48	15.63	1.32	1.32	0.70	0.85	0.75	0.05	-0.22	0.35
WTBR2	34.48	39.33	39.59	39.79	40.34	40.69	31.86	42.68	41.43	6.21	-2.62	8.20	6.95	1.36	-7.73	2.89	1.09

Risk to vegetation

Green	Low
Light yellow	Moderate
Orange	High
Red	Severe

Appendix B

DWER Compliance Report Extract

Appendix Table B.1 Current Actions as they Relate to DWER Audit

Section	MS971 Audit Comments (Department of Water and Environmental Regulation, 2022)	Newmont Response 14 June 2022 (Newmont Boddington Gold, 2022)	Current Related Actions
971:M7.1	Monitoring results indicate that groundwater drawdown is occurring. The report did not include reference to the percentage decline in plant cell density. Therefore, there is no information provided to make conclusions on the impacts of drawdown on vegetation health with reference to triggers and thresholds. The proponent is required to provide verifiable evidence that groundwater drawdown is not having a long-term adverse impact to the environment.	Based on current investigations, Newmont's opinion is that groundwater drawdown is not having any long-term adverse impacts to the environment....... Umwelt Environmental & Social Consultants has been contracted to establish and monitor baseline monitoring transects with a planned report due August 2022. In addition, Big Dog Hydrogeology and Umwelt have been engaged to review the GGDVMMP to provide recommendations for better alignment with MS 971.	Umwelt (2023d, 2023e, 2023c, 2023b, 2023a, 2024) PCD analysis reports continue to show no evidence of groundwater drawdown activities being responsible for PCD declines. Big Dog Hydrogeology (2022, 2025) completed an assessment of groundwater depths and links to relevant GDV areas. The outcome of Big Dog Hydrogeology reviews included recommendations for changes to the GGDVMMP which will be addressed by Umwelt during current review of the plan.
971:M7:3	*Attachment 3:* It is not possible to assess if the trigger and threshold criteria have been exceeded at other bores and areas of GDV, as the change in metres of groundwater levels has not been presented in the Compliance Assessment Report (CAR). Inadequate implementation of the GGDVMMP is a potential non-compliance with Statement 971.	The GGDVMMP was submitted to DWER in August 2019 but was not approved until July 2021. The document went through various revisions during this time. DWER's findings demonstrate that the language of the GGDVMMP reporting did not align with that of the trigger and threshold criteria outlined in the GGDVMMP. This has been reviewed. A hydrogeologist was commissioned to review the drawdown influences of the Westwood borefield as more data was available from a longer period of operation. The recommendations from this review	Big Dog Hydrogeology (2022) completed a groundwater assessment into current groundwater triggers. A summary table with the comparison of observed levels to the triggers is included in **Table A.1**. The outcome of Big Dog Hydrogeology reviews included recommendations for changes to the GGDVMMP which

Section	MS971 Audit Comments (Department of Water and Environmental Regulation, 2022)	Newmont Response 14 June 2022 (Newmont Boddington Gold, 2022)	Current Related Actions
	The proponent is required to provide a determination against each trigger and threshold criteria using verifiable evidence as outlined in Table 2 of the Groundwater and Groundwater Dependent Vegetation Monitoring Report.	were used to amend the Regional Borefield Management Procedure in Q2 2021. Newmont recognises the disconnect between these internal triggers established under the Regional Borefield Management Procedure and those developed for GGDVMMP. Newmont has commissioned a consultant hydrogeologist to assess this gap and revise triggers which will be adopted for both plans to ensure consistency.	will be addressed by Umwelt during current review of the plan.
971:M7:4	*Attachment 3:* The report does not reference the percentage decline in PCD between the monitoring periods as outlined in the plan. Only qualitative descriptions of the PCD change are included. Therefore, it is not possible to assess if the trigger and threshold criteria have been exceeded for any of the GDV areas. Inadequate implementation of the GGDVMMP is a potential non-compliance with Statement 971. The proponent is required to provide a determination against each trigger and threshold criteria using verifiable evidence, as outlined in Table 2 of the Groundwater and Groundwater Dependent Vegetation Monitoring Report.	No specific response to this audit comment was identified in the Newmont response.	Umwelt continues to be engaged to complete annual PCD reporting. To date has not been considered that BGM groundwater drawdown activities were responsible, fully or in part, to PCD loss and trigger criteria exceedances in potential GDV sensitive areas.
971:M7.5	The proponent has reported groundwater drawdown that appears to exceed the threshold criteria outlined in Table 2 of the	As discussed above, upon further review of the 2020 data and draft GGDVMMP which had been submitted to DWER in August 2019, not all trigger and threshold	Big Dog Hydrogeology (2022) completed a groundwater

Section	MS971 Audit Comments (Department of Water and Environmental Regulation, 2022)	Newmont Response 14 June 2022 (Newmont Boddington Gold, 2022)	Current Related Actions
	GGDVMMP. The proponent has not provided a determination against the triggers and thresholds as required by the condition. The proponent is required to provide a determination against each Trigger and Threshold criteria using verifiable evidence, as outlined in Table 2 of the Groundwater and Groundwater Dependent Vegetation Monitoring Report.	level response and contingency actions listed in Table 2 of the Plan were implemented following the change in groundwater levels at HFBR2S during 2019 and 2020. Whilst no visible impact to vegetation was evident over that period (which was reinforced by the PCD assessment), there is a need to review these triggers and to establish triggers for these sites which can be more easily tracked. The findings of the Westwood borefield drawdown influences (Big Dog, April 2021) indicated HFBR2S is highly reactive to the operation of Westwood production bore 8 (WWB8). When WWB8 is off, water levels in this bore can increase by up to 3m within a month. Restarting WWB8 does see drawdown of this bore until it reaches the maximum depth of the bore casing. Current trigger and threshold levels established for this site will be reviewed, given the PCD monitoring for this area is not detecting any significant change in vegetation health – different to vegetation extending along the Hotham River well outside of any mine or production bore groundwater influences.	assessment into current groundwater triggers. A summary table with the comparison of observed levels to the triggers is included in **Table A.1.** The outcome of this included recommendations for changes to groundwater triggers in the GGDVMMP Changes recommended by Big Dog Hydrogeology are detailed in **Section 4.2.3.1**, with Umwelts recommendations on how to carry out these changes detailed in **Section 3.0**.

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