Recalculating the Gamsberg Biodiversity Offset in light of new prospecting

A report prepared for EndemicVision on behalf of Black Mountain Mine / Vedanta Zinc International.

M Botha and P Desmet

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Author contact details:

Mark Botha Pr.Sci.Nat (MSc (UCT))
Conservation Strategy Tactics & Insight; 43 Sea Cottage Drive, Noordhoek 7979, South Africa;
Telephone: +27 21 789 0684; Cell: 084 5888 346; Email: Mark@ecological.co.za
Dr Philip Desmet Pr.Sci.Nat (Hons (Wits), MSc and PhD (UCT))
84 Clearwater Road, Lynnwood Glen, 0081; Telephone: +27 12 348 0577; Cell: 082 859 8751;
Email: drphil@ecosolgis.com

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Declaration: I am an independent specialist service provider that has been designing and negotiating biodiversity offsets for government and corporate clients since 2011. I have no interest in Black Mountain Mine or its agents or operations and declare that I act independently and without influence from any party.


23 May 2018

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1 Summary

This report provides a brief quantification of the expected residual impact of new prospecting on Gamsberg. It analyses initial proposed and revised prospecting plans, proposes appropriate metrics for the offset, and finally outlines the proposed additional offset and compensation requirements should potential impacts be realised.

As context, the original mine offset is summarised. The original offset study indicated that the authorised mine impacts on two habitats in particular, Plateau Fine Quartz Gravel and Calcrete Gravel Habitats, which are effectively 'not offsetable'. Although the offset is in process of being implemented, several impacted habitats have still not had their initial required targets met through the four offset properties secured thus far.

An iterative process was run to reduce impacts from proposed prospecting. A revised drill plan incorporated a total of 80 drill sites, of which 41 were on existing, previous drill pads. Multiple holes will be drilled from the bulk of these pads. Further, 39 new drill pads were proposed - only 2 of which are in the Plateau Fine Quartz Gravel Habitats, but located on existing active roads to reduce their impact as far as feasible. Of the 39 new drill pads, 32 are proposed on existing roads and it is assumed that this will reduce the impacted area by 27% per drill pad. A total of 11.19km of tracks are proposed, of which 2.051km would be entirely new impact, in the less sensitive habitats.

The revised prospecting plan indicates that an additional loss of 3.91ha Mountain plateau, 0.75ha of Plateau Quartz gravel, 1.22ha of Plateau Fine Quartz gravel, 1.05ha of Plains Quartz gravel, and 4.91ha of Rocky Plains is to be expected. Almost the entire area falls into a Critical Biodiversity Area (CBA) in the Northern Cape CBA map. A suite of ratios was applied to the impacted features, depending on whether they should be construed as CBA1 (30:1), CBA2 (which not in pristine condition but should be rehabilitated to meet biodiversity targets - 10:1) or Previously Impacted (e.g. active roads – no offset required). The required additional offsets are 3.7ha of Mountain plateau and 4.9ha of Rocky Plains. No offset is possible for the additional 19.7ha of Plateau Fine Quartz Gravel required. This additionality can be reduced by further modifying the prospecting plan to avoid this area or achieved through "trading-up" to secure other important biodiversity features in the Bushmanland Inselberg Region. The current four offset properties are not sufficient to have satisfied the original offset requirements nor the additional impacts from prospecting.

Options are suggested for pursuing the offsets for those impacted habitats for which these are still available, and trading-up compensation is suggested for the non-offsetable habitats. A detailed estimation of the additional costs to compensate for the non-offsetable impacts is only possible once the original offset has been complied with and a further suite of options for securing biodiversity targets arrived at. The quantum of additional area required to be secured is likely to be less important in determining the costs than the available mechanisms. These mechanisms should not be unnecessarily constrained in order to improve the likelihood of successful implementation of these mitigation measures. The appropriate compensation and financial implications in both cases need to be finalised through negotiations between DENC and BMM.

2 Introduction

Vedanta Resources purchased Black Mountain Mine (BMM) and the associated rights in 2011 with a view to pursuing the Gamsberg Zinc resources. Dr Philip Desmet and Mark Botha were contracted to develop a biodiversity offset as a requirement for environmental authorisation. This study was compiled in 2013, and an implementation agreement for the Offset was concluded with DENC in October 2014. Part of the Offset requirement was the setting aside and protection of the Gamsberg South and Eastern sections and to manage these sections for biodiversity as part of the mine's environmental management plan. Subsequent to this, BMM are keen to refine their estimates of the deep Zinc resources that lie under the southern and eastern parts of Gamsberg through additional prospecting. A Basic Environmental Assessment Process was commissioned in 2017, which triggered a range of concerned responses about potential additional impacts on the set aside areas. The author was contracted to update the likely offset requirements for BMM given the prospective additional impacts.

This document outlines the approach, context and preliminary calculations for the additional biodiversity offset requirements for prospecting on Gamsberg. It is designed to clarify the further requirements for the Offset. It does not provide a comprehensive picture of the mine impacts; offset policy; or progress with implementation of the original 2014 Offset.This Offset Recalculated report should be read in conjunction with the original Gamsberg Offset Report (Botha, Desmet and Brownlie 2013), the finalised implementation agreement (October 2014), as well as the Review of the Black Mountain Mine Biodiversity Management and Monitoring (ERM 2016).

The proposed offset implications presented here are based on extensive expert site study, the specialist reports conducted for the BAR, and perspectives gleaned from field trips. The field work EndemicVision 2018b) aimed to verify site specific impacts based on a worst-case scenario for the prospecting scope of works provided to the consultants as well to guide a revised Prospecting plan. It will be complemented by additional studies on the progress with rehabilitation and monitoring of specific indicator impacts (especially dust) and species (primarily *Conophytum*).

This report provides a brief quantification of the expected residual impact of the initial and revised prospecting plans, proposes appropriate metrics for the offset, and finally outlines the proposed additional offset requirements should potential impacts be realised. This is accompanied by a professional perspective on the most effective way forward to discharge the offset obligations.

According to clause 14.10 of the Offset Implementation Agreement, an independent audit of the efficacy of the agreement must be conducted by October 2019, and its outcomes submitted for public scrutiny in the AFS of Vedanta/BMM and the DENC annual report to provincial legislature. It seems appropriate for the audit to take into account the findings of this revision to the offset requirements.

3 Project Brief

As per the terms of reference - Please provide a detail biodiversity value assessment of prospecting impacts using:

1. Original extent of impact (original best drilling program) + Big sync areas (new work planned)
2. Using final extent of impact (drill pads reduced, avoidance and mitigation measures applied)
    a. Assessment of available offset areas and extrapolation of costs using current offset calculations

   b. Presentation of management recommendations in terms of the above, indicating best, probable, worst case scenarios
   c. Client presentation of results - on site"
2. Interpretation: Consultant will - 1. Review detail assessments from botanical specialists (and project details, previous assessments, and other specialists' biodiversity and other impact reports) and mitigation and offset recommendations. Contrast with previous EIA mitigation requirements (and offsets).
3. Confirm likely residual impacts, offset requirements (especially in light of the existing Gams offset agreement) and likely offset sites and costs for extension of the offset areas, including appropriate management responsibilities
4. Provide succinct Offset parameters into the EIA process or decision processes, craft offset high level report and specific Conditions of Authorisation for submission in final EIR / or to amend any applicable offset related agreement.
5. Develop proposed financial components of the Offset for discussion by the parties – to be presented to client on site.

4 Context

EndemicVision assembled a team to investigate the likely impacts from proposed prospecting on the Eastern and Southern portions of Gamsberg, as well as the Big Syncline (a separate report will be compiled for this). This report is the perspective of the Offset specialist, and complements other studies on monitoring of key species, and the progress and extent of rehabilitation. It analyses an initial proposed prospecting plan for Gams East & South as well as a revised plan which was submitted after presentation of the offset implications.

4.1 Original offset

Beyond the regulatory requirement for an offset, Vedanta's Technical Standard for Biodiversity Management (version of 30 September 2011) states that net positive gains shall be designed for any "critical habitat" impacts that cannot be avoided, and that mechanisms will be used to achieve No Net Loss and improve biodiversity outcomes wherever possible. The standard notes further that offset mechanisms are to adhere to 'like for like or better' principle. The Standard also references compliance with the IFC Performance Standard 6 on Biodiversity. To satisfy IFC PS6 requirements, an offset is needed as both Natural and Critical Habitat will suffer residual impacts.

The original Offset Report (Botha et al 2013) stated that "*Many habitat/ feature targets can be met through purchasing or otherwise securing biodiversity on farms in the region. Securing the optimal portfolio of properties would achieve the targets set (and the No Net Loss test) for most features* ***except*** *Fine Plateau Gravel Quartz and the Calcrete Gravel patches. Targets for the 'Critical habitats' Aggeneys Gravel Vygieveld Mountain Plateaux and Plateau Quartz Patches would meet Net Gain criteria if and only if the Mine properties Aggeneys 3941, Aggeneys 3940 and Gams 60/1 and Gams 60/4 were also protected from further biodiversity loss. This requirement has significant implications for the permissible mining methods that could be pursued on these properties to exploit the Big Syncline and Gamsberg South and East ore bodies*."

The efficacy and progress with implementation of the original offset is covered by ERM (2017). It appears that although progress has been made, there is a loss of institutional memory about the intent and finer nuances of the original offset – which complicates a new analysis of additional offset requirements from new planned works. Further, as some of the impacted habitats are technically not-offsetable, commenting authorities,

biodiversity partners and regulators will have to take a view on what appropriate compensation measures should apply.

4.2 Additional impacts from Prospecting

4.2.1 Initial prospecting proposal

An initial set of 114 drill sites/collars and 30.34km of their associated access tracks roads was analysed by overlaying them on the original fine scale vegetation map of the Gamsberg (see Figure 1). Roads were classified as 'planned roads' or 'existing tracks' (single tracks off main roads). Roads were assumed to be graded to a width of 4m which accords with existing impacts in other prospecting areas around BMM. Each drill site was initially assumed to permit one drill hole. Drill sites were assumed to be 225m^2 each. See EndemicVision (2018b) for detailed assessments. Limited discounting for existing disturbance was taken into account as many of the previous access tracks and drill sites are in various stages of natural regeneration.

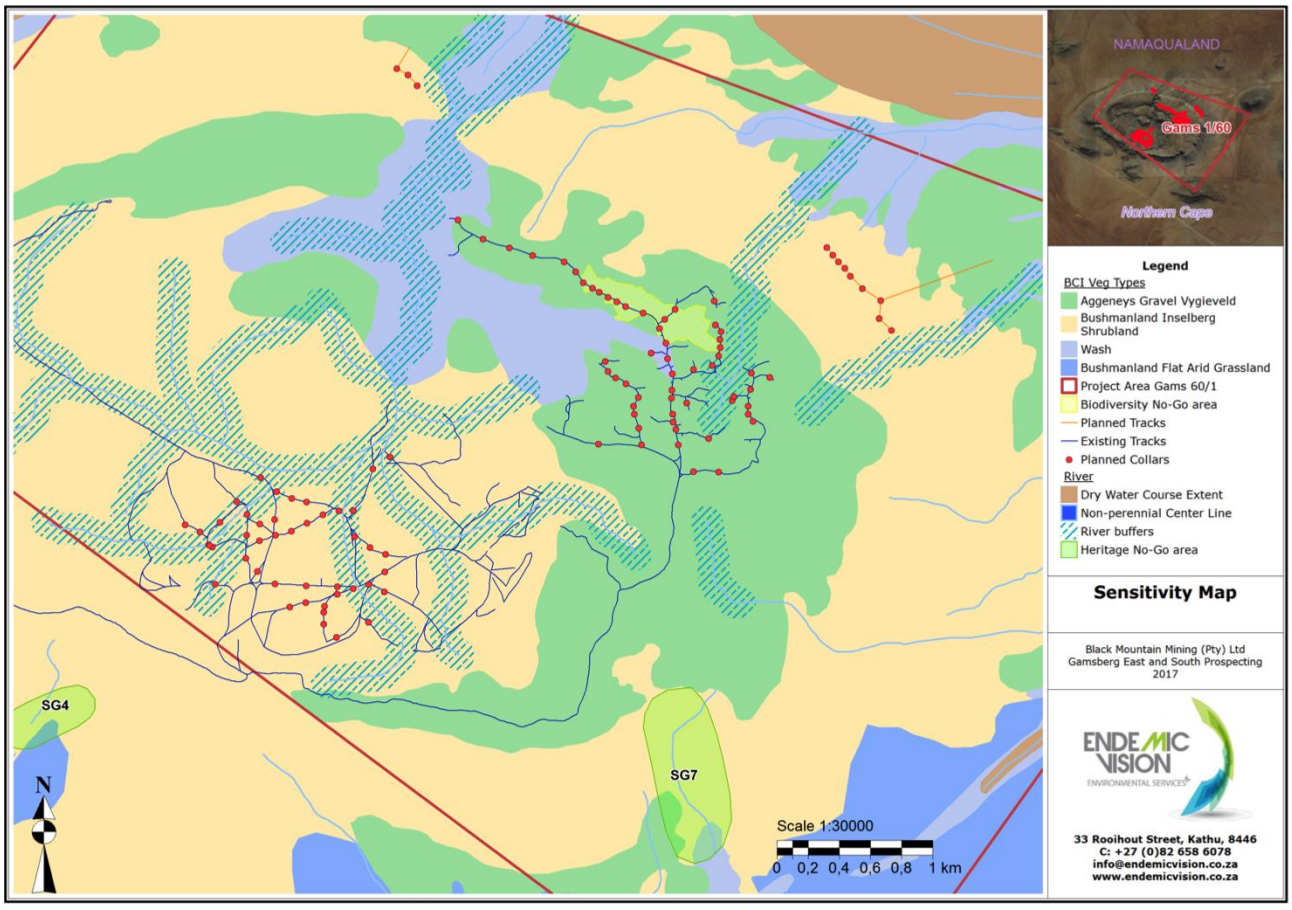

Figure 1. Initial prospecting proposal submitted by BMM exploration for Offset impact analysis

Spatial analysis comparing the prospecting footprint to biodiversity sensitivities yielded the following impacts (Appendix: Methodology for Determining Biodiversity Sensitivity and Area of impact):

1- Tracks and planned roads totalled 12.136ha, of which 10.27ha was in Aggeneys Vygieveld (Critical Habitat) and of that 0.56ha in Plateau Fine Quartz Gravel Habitats.

2- Drill collar impacts totalled 2.565ha, of which 2.13ha was in Aggeneys Vygieveld and of that 0.36ha was in the Plateau Fine Quartz Gravel Habitats.

Owing to the prospecting being located in a Critical Biodiversity Area 1 and in an area that has been set aside for biodiversity protection to meet the requirements of the original offset it was assumed that a ratio of 30:1 (offset area: impact area) would apply.

This information was presented to a meeting of the EAP, specialists, BMM exploration geologists, and the BMM Biodiversity Manager. Discussion around the exact locations of sensitive habitats, more appropriate discounting for existing impacts and disturbed areas, likely realignment of tracks, and alternative drilling methods resulted in a revised drill plan being submitted to minimise as far as possible the impacts on sensitive features.

4.2.2 Revised prospecting proposal

To clarify the appropriate sensitivity of the biodiversity features on Gamsberg, the full suite of features on Gamsberg were assigned nominal values based on whether they could be construed as "Critical Habitat" or "Natural Habitat" within the CBA1[1] designation (see Table 3 below). This allowed a sharper distinction to be made between the most important habitats to be avoided and which could effectively be classified as "CBA2" for purposes of determining appropriate offsets (see section 5.2.) The Plateau Fine Quartz Gravels, Headwater seep, and a buffer around Pans were assigned sensitivity scores of 10000, while the Kloof and its catchment habitats were assigned scores of 1000. Buffer areas around the kloof and gravel patches were assigned 100. Previous impacted areas such as active roads were assigned a value of 0. A detailed explanation of the methodology is given in the Appendix (Section 9). This was used By BMM Exploration to devise a new prospecting plan. See Figure 2.

The revised drill plan incorporated a total of 80 drill sites, of which 41 were on existing, previous drill pads. Multiple holes will be drilled from the bulk of these pads. Further, 39 new drill pads were proposed - only 2 of which are in the Plateau Fine Quartz Gravel Habitats, but located on existing active roads to reduce their impact as far as feasible. Of the 39 new drill pads, 32 are proposed on existing roads and it is assumed that this will reduce the impacted area by 27% per drill pad. A total of 11.19km of tracks are proposed, of which 2.051km would be entirely new impact, in the less sensitive habitats.

4.3 Exhausting the mitigation hierarchy

Offsets studies should satisfy the requirement that the mitigation hierarchy has been exhausted. A summarised account of the iterative mitigation process followed and the decisions taken to effectively exhaust all other mitigation options is given in the BAR (EndemicVision 2018a). I am satisfied that there is little additional mitigation beyond further offsetting or compensation that the prospecting team could undertake to avoid or minimise impacts without compromising their ability to more accurately determine the ore body.

[1] CBA is a Critical Biodiversity Area, one that must be maintained in a good ecological condition in order to meet biodiversity targets. CBA1 is irreplaceable (natural or near-natural condition), and CBA2 in this context refers to an area that should be CBA1 but is impacted and requires rehabilitation to fulfil its ecological role.

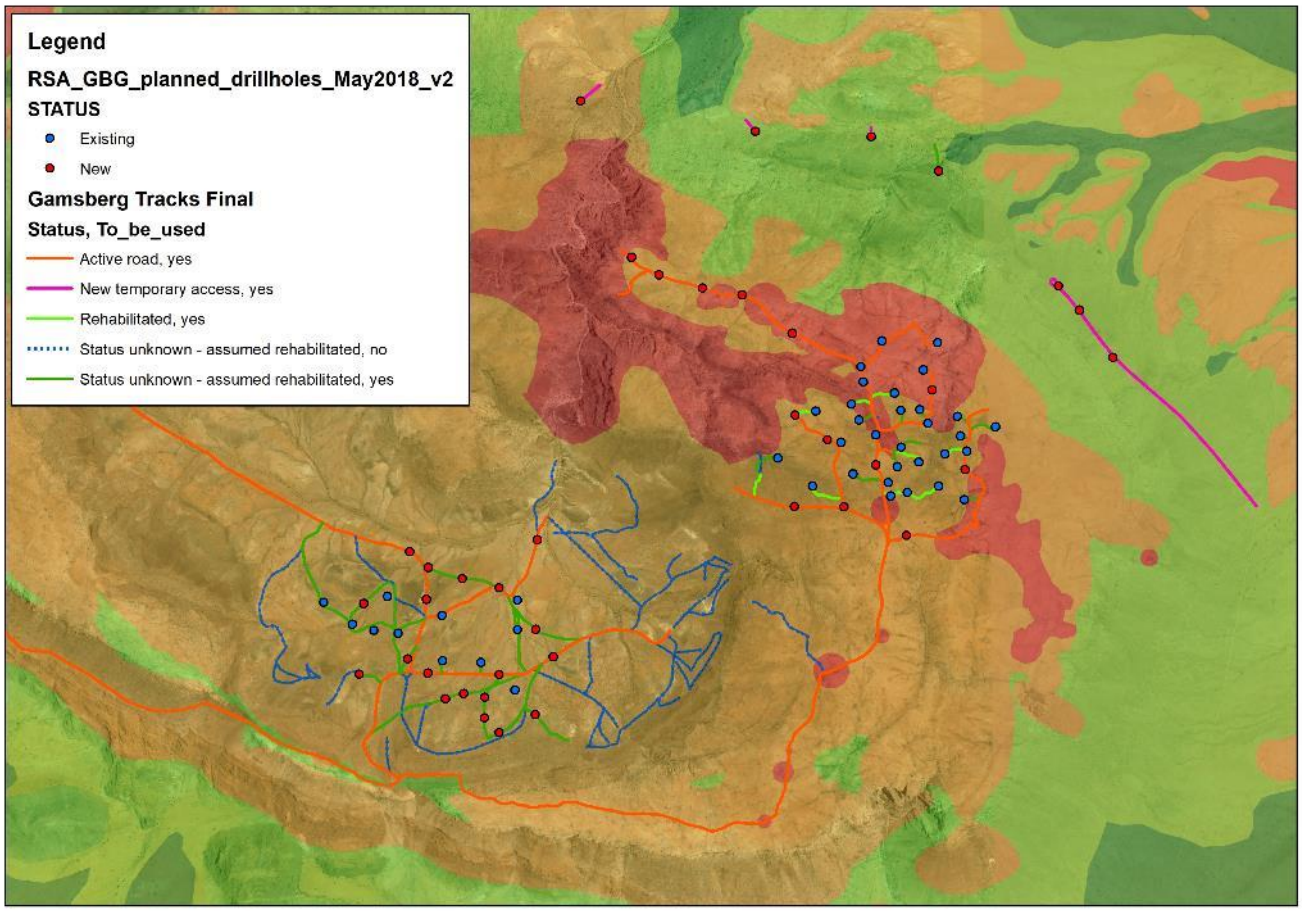

Figure 2. The revised prospecting layout (Drill Plan v2) showing active and rehabilitated roads, existing and new proposed drill pads, and the summed sensitive underlying biodiversity features on Gamsberg. Red areas indicate the most sensitive habitats.

5 Offset parameters

5.1 The form and nature of acceptable biodiversity offsets

It is useful to clarify the important conceptual differences between **trade-offs**, **compensation** and **offsets**. These mean different things, and have rather different outcomes.

A measure must satisfy the principles above to call itself an '**offset'.** In particular, an offset would not undermine conservation targets or lead to irreplaceable loss of biodiversity, and would be commensurate with the residual impacts of the proposed activity[2].

If a measure does not satisfy these principles, and instead offers some form of remedy that is not commensurate with, equivalent in type, or is insufficient to qualify as an offset (although it could contribute to meeting the target of the affected component biodiversity), then it would be termed '**compensation'**.

[2] In the international context of the IFC PS6 and the BBOP Standard, an offset must achieve NNL or net gain; any measure that does not achieve that outcome would be termed 'compensation'.

A **'trade-off'** is typically made between, rather than within, different categories or 'pillars' of capital (e.g. between socioeconomic benefits and biodiversity loss). A trade-off is not to be confused with 'trading-up' which can be accommodated in the offsets framework, and allows impacts on one biodiversity feature to be offset by safeguarding another biodiversity feature of greater value and/or under greater threat.

Ultimately, even if an offset is deemed unacceptable due to, for example, the irreplaceability of the impacted biodiversity, ecological process or the ecosystem service being lost, this would not impede a regulator's ability to require compensation, or even to make a trade-off, provided that such compensation or trade-off is made within our legal framework and is defensible. In this situation, however, compliance with either Vedanta's policies and/ or the IFC PS6 would not be achieved.

Biodiversity offsets can be achieved by:

- Increasing a target site's security against land use change, in the long term
- Restoring or repairing degraded areas (although this is limited in the brittle habitats of Bushmanland)
- Improved management, and/ or
- Preventing likely transformation or degradation of areas through formal/ legal protection.

For protection and restoration to be effective in the offset context, they should endure in perpetuity, and be accompanied by significant land use and allied protection mechanisms to safeguard the biodiversity features for which they initially set aside.

While it may be possible to achieve net gain in some critical habitat through successful restoration (of structure, function or condition), it is almost always preferable, in the South African context, to conserve a more pristine expression of the type, habitat or feature first.

Research work, education and/ or capacity building are not acceptable forms of offset, since their 'on the ground' outcomes cannot be measured, and would be better conceived of as trade-offs.

5.2 Offset ratios

The quantum of biodiversity offsets in South Africa has historically used a basic ratio derived from a target which is in turn linked to the status[3] of residually affected ecosystems. Multipliers are often applied to this basic ratio where:

- the condition of biodiversity in the impacted area is significantly better or worse than the offset receiving area
- the area comprises a component of a wider landscape recognized as having high conservation importance;
- the area supports several threatened species or species of special conservation significance; and/ or
- there is either a lack of confidence in impact predictions and/ or a risk of failure of proposed measures to avoid, mimimize or rehabilitate/ restore negative impacts within stated time frames, implying that residual impacts would be greater (in extent and severity) than initially estimated.

There is little experience in South Africa with quantifying the metrics associated with these multipliers and applying these to specific situations. We take our cue from draft national policy (DEA 2017) guidelines for

[3] The NEM: Biodiversity Act (Act 10 of 2004) provides for gazetting the threat status of different ecosystems. Notation used is the same as for Threatened species. Endangered = EN, Least Threatened = LT etc. The most recent list was published in 2011.

relevant ratios and multipliers where a simpler approach has been adopted. These guidelines have been comprehensively revised since then, and it seems prudent to use the most cautious interpretation in the absence of anything else. This implies that any area identified as CBA1 requires an offset ratio of 30:1, and any area identified as CBA2 requires an offset ratio of 10:1. An area that was shown to have no remaining biodiversity value (e.g. an active road through a widespread vegetation type in an 'insensitive' area) was assigned an offset ratio = 0.

5.3 Designing the offset

The design of the final offset portfolio is dependent on several factors:

- The location and proximity of existing protected areas which may be expanded or consolidated
- The distribution of those biodiversity features and components of the offset across properties in the region
- The availability of specific properties on the market and/or the willingness of the owners to sell them or have them encumbered with offset restrictions
- Consideration of the objectives of the offset area, and its specific management requirements or efficiencies (e.g. having a sensible boundary to secure and avoiding disjointed management units that cross communication and transport lines)
- Capitalising on existing or proposed land use developments that could augment the offset and increase establishment success, and avoidance of current and future land use conflicts.

6 Determining the required additional Offset

6.1 Assumptions, limitations, uncertainties and risks

The following assumptions have been made for the quantification of the 2018 Gamsberg prospecting offset requirements.

- The offset study must assume that all possible and required mitigation has been undertaken by the mine, and these requirements have been assessed and/or approved by the relevant regulatory authorities. In particular, that the habitats set aside and conserved on BMM owned land will be protected and managed for biodiversity for at least the duration of the impacts of the mine.
- Offset design must cater for worst case scenarios, applying a risk-averse and cautious approach in accordance with the requirements of NEMA's environmental management principles.
- With the exception of the sandy plain habitats no impacted area has the potential to be restored to or near their original condition within the life of the mine and its closure phase as the required ecological timeframes are far greater than the span of the closure plans. The physical and biophysical environmental qualities (including the specific particle size, soil structure and organism dynamics such as lichens, fungi and organic crusts) that determine these habitats cannot be recreated.
- The effectiveness of proposed mitigation actions around drill rigs is unclear. The rehabilitation assessment (EndemicVision 2018b) noted that residual impacts still affect rehabilitation potential, including drill sludge residue, soil structure impacts from erosion, inverted soil profiles, and irreversible compaction (not possible to mechanically address in the quartz habitats). Rock packing can be replicated after drilling, but quarts layering cannot be recreated.
- The micro scale processes and ecological drivers on Gamsberg make it unique. Normally ecological drivers (like grazing) can be used to assist rehabilitation, but this is not possible on Gamsberg.

- Impacts of fragmentation by roads is unclear.
- Best mitigation remains footprint reduction and avoidance. This study must assume that footprint impacts will not be any larger than catered for in these calculations.

6.2 Quantifying the Offset required

As noted in the original offset report, some impacted features have limited regional extent within the Core Inselberg Region. Where the impacts of the mine and prospecting on a particular habitat type result in the remaining area of that habitat being less than the area required to meet conservation targets, the residual impacts cannot be offset. In this situation, it would not be possible to satisfy either No Net Loss or Net Gain outcomes for affected component of biodiversity.

If offset requirements cannot be met within this target area due to the constraint to meet the offset target in the core Bushmanland Inselberg Region, and where the risk of undermining achieving conservation targets for particular impacted feature(s) was low, they could be traded-up to achieve conservation targets within the offset protected area for other impacted features or features occurring locally but not impacted by the mine. Alternatively, offset targets could be sought in the wider region through piecemeal agreements with landowners, but would not in all likelihood be optimally protected or managed and are unlikely to be accepted by DENC or biodiversity partners. Some trading up possibilities are suggested in section 6.3.1.

6.3 Verifying Offset sufficiency and identifying shortfalls

As of writing, BMM has secured four of the required seven properties for the original offset. Using the contributions of these properties to the required fine scale habitats of the affected vegetation types, Table 1 shows that there are shortfalls in four of the required habitats. The revised prospecting plan indicates that an additional impact of 3.9ha Mountain plateau, 1.2ha of Plateau Fine Quartz Gravel, 1.05ha of Plains Quartz gravel, and 4.9ha of Rocky Plains is to be expected (Table 1). Other impacts are not technically relevant as their corresponding offsets have already been achieved through the original four offset properties secured. The required additional offsets are 3.7ha of Mountain plateau, 19.7ha of Plateau Fine Quartz Gravel, and 3.4ha of Rocky Plains. The current four offset properties are not sufficient to have satisfied the original offset requirements nor the additional impacts from prospecting.

Three habitats have exacerbated shortfalls due to the proposed prospecting impacts: Mountain plateau, Plateau Fine Quartz Gravel, Plains Quartz Gravel habitats in Aggeneys Gravel Vygieveld. Calcrete Gravel habitats still require over 1500 ha to be secured to satisfy the original offset. This habitat is not being impacted by prospecting. It is not clear if the final original offset properties may make up any of the shortfall due to prospecting for Mountain Plateau habitats, but given the area available it is likely that the original offset will make up the additional requirement. For Plateau Fine Quartz Gravel the additional requirement cannot be achieved. The original offset already asks for 100% of the total available in the BIR. The prospecting adds a further 18% to this target, which is unattainable. Any impact in the Plateau Fine Quartz Gravel cannot be offset with like for like and would require trading up.

Table 1. Original offset summary table, Habitats, Offset required, No-Net-Loss and Net Gain tests, and remaining offset requirements prior to prospecting impacts.

Vegetation Types;Habitat units and Conservation status	Original offset required[4]	Not offset-able[5]	Optimal portfolio	Mine properties	Current portfolio	No Net Loss test	Net Gain test	Total area[6] secured over/under target
Aggeneys Gravel Vygieveld								
Mountain plateau; Constrained (VU)	1 090		812	420	553.5	Yes	Yes	-121
Plateau quartz gravel; Irreplaceable (VU)	309		**174**	**137**	**91.7**	**Yes**	**yes**	**-80.3**
Plateau quartz gravel (fine grain); Irreplaceable (VU)	58	**49**	**0**	**9**	**0**	**No**	**No**	**-49**
Plains quartz gravel; Irreplaceable (VU)	1 830		2 158	844	887.9	Yes	Yes	-98
Plains quartz gravel intermediate; Constr. LC	56		257		252.3	Yes		196
Plains feldspar gravel; Constrained LC	91		1 102		1102	Yes	Yes	1 011
Plains rocky; Constrained LC	349		3 636		5628		Yes	3 287
Bushmanland Inselberg Shrubland								
Mountains; Flexible LC	1 306		14 523		3013	Yes		13 217
Southern Slopes; Irreplaceable (VU)	886		1 736		609	Yes		850
Bushmanland Arid Grassland								
Flat sandy plains; Flexible LC	2 394		12 724			Yes		10 330
Hummocky sandy plains; Flexible LC	334		8 706			Yes		8 372
Calcrete gravel plains; Irreplaceable EN	1 732	**404**	**256**	**?**	**222.36**	**No**	**No**	**<-600**
Bushmanland Sandy Grassland								
Mobile sandy dunes; Flexible LC	5		>1 000		183	Yes		> 1 000
Azonal Habitats & Features								
Kloof;(Irreplaceable)	all		**1 Kloof**			**No**		
Freshwater springs & Head-water Seep; (Irreplaceable)	all Springs		**1 Spring**	**1 Spring**		**No**		
River (Wash with sub-surface flow); Flexible	1 533		2 040			Yes		507
Wash;(Constrained)	723		4 293		1735	Yes		3 570

Key to shading:	Net Gain achieved by optimal offset portfolio **And** Mine properties	No Net Loss test failed	**Area of specific vegetation types still required**	**Technically not offset-able due to impact**

[4] This is the lesser of the Target or the regional extent of the habitat

[5] Due to the impact of the mine on target habitats

[6] By the current offset portfolio. This assumes that relevant portions of Mine property are set aside for conservation in perpetuity

Table 2. Gamsberg Offset Requirements, Contributions from mine properties, existing Offset portfolio and additional requirements from new proposed prospecting impacts (v3). Habitats shaded in green have their offset target achieved in the current portfolio. Habitats shaded in yellow ae under target but this target can still be achieved. Habitats shaded in red have a target greater than what is available and therefore can never be achieved.

Vegetation Types and Habitat units	Original Offset Required	Original extent in Bushmanland Inselberg Region	Mine properties	Current portfolio	Initial prospecting Impacts (ha)	Revised prospecting impacts (ha)	Additional Offset required (ha)	Total area secured over/under target + additional requirement (ha)	Total area secured as % of new target
Aggeneys Gravel Vygieveld					**13.77**	**11.831**	**26.753**		
Mountain plateau; Constrained	1090	1763	420	553.5	5.34	3.914	3.719	-120.219	-11.03
Plateau quartz gravel; Irreplaceable	309	449	137	91.7	0.74	0.746	0	-80.3	-25.99
Plateau quartz gravel (fine grain); Irreplaceable	58	58	9	0	0.92	1.219	19.669	-68.669	-118.39
Plains quartz gravel; Irreplaceable	1830	5974	844	887.9	0.5	1.047	0	-98.1	-5.36
Plains quartz gravel intermediate;	56	1201		252.3				196.3	350.54
Plains feldspar gravel; Constrained	91	1237		1102				1011	1110.99
Plains rocky; Constrained	349	11723		5628	6.27	4.906	3.365	5275.635	1511.64
Bushmanland Inselberg Shrubland						**1.964**	**1.637**	**-1.637**	
Mountains; Flexible	1306	42037		3013	1.18	1.964	1.637	1705.363	130.58
Southern Slopes; Irreplaceable	886	4597		609				-277	-31.26
Bushmanland Arid Grassland						**0.483**	**0**	**0**	
Flat sandy plains; Flexible	2394	148057		6823		0.483	0	4429	185
Hummocky sandy plains; Flexible	334	105803		673	0.5		0	339	101.5
Calcrete gravel plains; Irreplaceable	1732	1732		222.36				-1509.64	-87.16
Azonal Habitats									
Kloof		847				0.204	1.011		
Wash	2257	32293	1736			0.42	0	-521	-23.08
Total						**14.901**	**29.401**		

Table 3. 'Critical Habitats', Features, and dependent species that cannot be offset due to the Gamsberg mine. The additional impacts from prospecting must be viewed in this context – modified from Botha et al 2013.

Habitat unit/ Species	***status***	***significance***	***Criteria or explanation***
Plateau Fine gain Quartz Gravel patches	EN	Very High. Additional impacts cannot be offset. Avoidance is only useful mitigation. Monitoring is required.	This is a rather localised habitat type, restricted to Gamsberg. Unique characteristics of habitat structure have allowed evolution of unique species forms. Not meeting this offset is significant for its impact on at least two species.
Conophytum ratum	VU (endemic)	It may go extinct in the long term. Population monitoring is required to verify impact.	Estimated that 80% of population restricted to the Plateau Fine-Grain Quartz Gravel patches of the Gamsberg. Although there are small populations that will not be directly impacted, the major one will be impacted by dust and activity around Gamsberg.
Conophytum angelicae subsp. *rubrohomoterrenum*	VU (endemic)	It may go extinct in the long term. Monitoring is required to verify impact	This sub-species is unique to the Bushmanland Inselberg Region. It is restricted to Plateau Fine-Grain Quartz Gravel patches.
Bushmanland Arid Grassland Calcrete Gravel Patches	EN	High. Significant for its impact on a unique and impacted species assemblage. However, areas will persist outside of the Offset area, and nearly 15% of its target is currently secured	This is a rather localised habitat type, restricted to Bushmanland. It is heavily utilised by stock. The extreme target set for this type and the pragmatic constraints on offset location prevents effecting offsetting of even a moderate impact. Although areas do exist outside of the core region that would allow approaching NNL, securing these would be extremely difficult and impractical. However, the habitat is likely to persist in Offset area in the long term.
Feature			
Kloof		High. Although one other kloof could possibly be secured, the loss of the largest one is significant	There are only two kloofs in the Bushmanland Inselberg Region. Both host a unique assemblage of species and provide a unique microclimate in this near-desert, allowing for persistence of relic species.
Head water seeps		High. This habitat and its associated species may occur outside the region	A unique local feature with an interesting assemblage, located almost entirely over the pit, it holds no endemic species.
Springs (and seasonal pools)		High	One other spring is located on mine land and one on an adjacent property, the loss of these two springs may be significant for dependent species.
Hydrodictyon sp nov.	Data Deficient	Undescribed aquatic species. Impact not classifiable.	The species may be found in other parts of the region, or may be new.

The following residual impacts (see Table 3) could not be offset in the core Bushmanland Inselberg area or the broader region, and would constitute a loss of biodiversity in 'critical habitat' or the loss of a valued feature of 'natural habitat'. This is due to the impact:

- preventing conservation targets from being achieved;
- leading to the likely extinction of species or the total loss of a particular habitat type;
- leading to a likely change in ecological processes on which persistence of threatened species / critical habitat is dependent.

The original Offset Report (Botha et al 2013) found that mitigation of unavoidable and non-offsetable residual negative impacts on these habitats required compensation only if the offset could not be secured in the core BUT could be found elsewhere AND was Natural Habitat and not Critical Habitat. See 6.3.1.

The proposed prospecting impacts further impact the Critical Habitat of Plateau Fine Quartz Gravels, as well as their attendant endemic species.

6.3.1 Proposals for compensating for non-offsetable residual impacts

The original proposals for compensating for the non-offsetable impacts remain valid for the additional offset requirements of the new prospecting on Gamsberg. In particular, residual impacts on the freshwater features of the Kloof, Headwater seeps, and Springs can perhaps best be compensated by securing similar systems (headwater seeps, springs and riparian zones) in neighbouring areas of the Eastern Gariep centre of Endemism. It is noted that the adjacent farm Achab has been secured for the offset which conserves the other known occurrence of a kloof and similar freshwater systems to those on the Gamsberg. However, this still constitutes a net loss. A more thorough and systematic comparison of the freshwater ecosystems in the Bushmanland Inselbergs and their regional importance would be an interesting project for academic contributors.

The residual impacts on the terrestrial habitat units (Calcrete Gravel Patches and Fine-grain Plateau Quartz Patches of the Aggeneys Gravel Vygieveld) that cannot be offset could be compensated for by:

1- Securing a larger contiguous extent of the Bushmanland Inselberg Region to include more inselbergs and Aggeneys Gravel Vygieveld as per the Northern Cape Protected Areas Expansion Plan (DENC 2017) for the Bushmanland Inselberg Region. Extending eastwards from Namies would secure other regional endemics not present in the west such as *Dinteranthus vanzylii* var. *lineata*.
2- Securing another regional vegetation type or habitat unit that is of limited extent, has unique or listed species communities, and is in imminent threat of extirpation.
3- Securing all the remaining habitat and populations of *Titanopsis hugo-schlecteri* on the Calcrete Gravel Patches. This is not contiguous with the offset and would be difficult to manage in the long term.

Additional compensation[7] for the Kloof, Headwater seeps, and Springs could be achieved by:

a- Identifying and protecting endangered wetlands in the adjacent Gariep Desert wetland systems to the North of the offset area, especially those areas also identified as CBA1 in the Northern Cape CBA map. These systems are listed a Freshwater Ecosystem Priority Areas priorities (Nel *et al.* 2011). This might be achievable in the long term by contracting adjacent private land into the Offset area once declared.
b- Identifying and protecting similar systems around the nearest two statutory protected areas in the Succulent Karoo, being Goegap Nature Reserve and Namaqua National Park. This approach would obviate the need to initiate a new protected area elsewhere in Bushmanland and the necessity of establishing and funding a management authority.
c- Alternatively, rehabilitation of the larger pans which have been drained in the Koa river system in Bushmanland might provide significant net positive impacts for avifauna. This would include control of invasive *Prosopis* spp in the broader landscape (i.e. beyond BMM owned properties) and would facilitate inclusion of additional land in the Offset target area in the long term.

[7] See section 5.1 for the definition and explanation of why these measures should be seen as compensation and not offsets. If the biodiversity feature being targeted is rarer, more threatened or more unique, then this compensation would be "trading-up".

A detailed estimation of the additional costs to compensate for the non-offsetable impacts is only possible once the original offset has been complied with and a further suite of options for securing biodiversity targets arrived at. The quantum of additional area required to be secured is likely to be less important in determining the costs than the available mechanisms. These mechanisms should not be unnecessarily constrained in order to improve the likelihood of successful implementation of the mitigation. The appropriate compensation and financial implications in both cases need to be finalised through negotiations between DENC and BMM (and presented to the DMR).

7 Revised Scope of the Gamsberg Offset

This report has set out the expected additional impacts from an initial and subsequently revised prospecting plan on the Gamsberg. It does not take into account the additional expected impacts from prospecting on the Big Syncline set aside area, or from any new planned infrastructure around the mine (such as the mooted smelter). It would make sense to formally revise the offset implementation agreement only once there is greater clarity on the full scope of anticipated biodiversity impact, acknowledging that there are some biodiversity features which are not offsetable and which should not be further compromised by BMM. This notwithstanding, the following additional offset actions should be considered by the regulators to inform mitigation requirements in conditions of authorisation for any prospecting activities on the Gamsberg.

7.1 Scope of Additional Offset actions

The following objectives comprised the scope of the original Offset.

1. Establish a core Protected Area through purchase and consolidation of the top 7 identified properties and those Black Mountain Mine properties where no mining is or is likely to take place, or the purchase of development rights or other rights to the land to:
    a. afford protection for ecosystems and/or habitats of affected species,
    b. increase ecological connectivity,
    c. restore ecological function, and
    d. facilitate management of the protected area.
2. Protect and manage (through the EMP, BAP and CAMP) the remaining Black Mountain Mine properties where an active mining right is held, as a 'Protected Environment' buffer to the Protected Area, with permanent land use restrictions on the surface biodiversity.
3. Securing an appropriate implementation agency to manage the proposed Protected Area.
4. Establishing a funding mechanism for the long-term management of the Protected Area.

The additional proposed prospecting impacts on specific habitat features cannot easily be offset by simply continuing with the original scope. It is suggested that modest additional inselberg areas (49.31ha) of Mountain Plateau and habitats analogous to the Plateau and Plains Quartz Gravels supporting rare and/or endemic species of the Aggeneys Vygieveld vegetation type are secured (as per 6.3.1). Further, to compensate for non-offsetable habitat impacts, that a broader approach to securing freshwater systems in the Bushmanland Region is pursued, preferably adjacent to the offset area, but failing this, adjacent to and easily incorporated into another statutory protected area in the Namaqua district.

7.2 Conditions for inclusion in EMP

- Complete the implementation of the original offset agreement, to the satisfaction of an external auditor, before proceeding with new impacts on biodiversity in the areas originally set aside for offsetting the mine impacts.
- This study on the additional offset requirements from prospecting on Gamsberg assumes that the quantification of residual negative impacts of the prospecting is reliable. Should monitoring highlight significant changes in impact predictions, it would be necessary to revisit the offset requirements accordingly, and it is worth including any recalculation as a specific term of reference for any audit process for the offset or environmental mitigation for Gamsberg and BMM.
- Table 1 and Table 3 above form an important component for any Monitoring and Evaluation framework that should be used to check the impact of the dust, mitigation measures to contain impacts, and the spatial footprint of the prospecting and road construction.
- It is imperative to formally augment the original offset implementation agreement (including the required offset quantum, specifics and most suitable target sites) only once there is greater clarity on the full scope of anticipated biodiversity impact from all prospecting activities and planned new infrastructure, acknowledging that there are some biodiversity features which are not offsetable and which should not be further compromised by BMM, but which can be compensated for through the measures suggested in this report.

8 References

Botha M, Desmet P and Brownlie S. (2013). *Scope of the Gamsberg Biodiversity Offset*. Final report submitted to Black Mountain Mine and ERM. April 2013.

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Nel, J, Murray KM, Maherry AM, Petersen CP, Roux DJ, Driver A, Hill L, van Deventer H, Funke N, Swartz ER, Smith-Adao LB, Mbona N, Downsborough Land Nienaber S. 2011. *The Atlas of National Freshwater Ecosystem Priority Areas.* WRC Report No. 1801/2/11 ISBN 978-1-4312-0149-5. WRC, DEA and SANBI. Pretoria.

9 Appendix: Methodology for Determining Biodiversity Sensitivity and Area of impact

9.1 Gamsberg East and South Biodiversity Sensitivity Analysis

Purpose:

The purpose of this analysis is to provide the Vedanta drilling team with a GIS input that summarises available biodiversity information into a single relative measure of biodiversity sensitivity as well as indicate potential for biodiversity offset.

This analysis integrates all available fine-scale mapped biodiversity information for the Gamsberg using a basic categorical ranking approach where each input is assigned a numerical category equivalent to a standard low-high ranking approach. The numerical categories are used as these simplify the GIS analysis, however, it does not indicate a quantitative relationship between features.

Each input feature was ranked according to the following scale:

- Low = 10
- Medium = 100
- High = 1000
- Very High = 10 000

Features were assigned a rank based on existing sensitivity rankings as well as the potential to offset features based on their availability in the wither Bushmanland landscape.

Any feature assigned a value of 10 000 indicates that this feature cannot be offset. In the final integration, the value is an indication of the number of overlapping features. For example: A polygon with a final rank of 32100 indicates that there are at total of 6 out of 9 possible features overlapping in that polygon: 3 features with rank of 10 000; 2 features with rank of 1000; and, 1 feature with a rank of 100.

Hydrological features are also included in the analysis as these areas are sensitive to chemical pollution that can arise from drilling. Environmental hazards such as steep slopes are not included in this analysis.

The output shapefile can be used in a "biodiversity cost" analysis to optimise the drilling program to minimise drilling impact on the mountain.

Input Data:

The following inputs were used:

	Description of Variable	Rank
1	Fine grain quartz patch map produced for Anglo Exploration in 2006. This map is based on walking boundaries in the fields and supplemented with mapping from Quickbird imagery	10 000
2	Location of all springs buffered by 50m	10 000
3	Areas of temporary pan concentration based on field observation	10 000
4	Headwater seep catchment boundaries modelled from DEM	10 000
5	Modelled kloof extent	1 000
6	Kloof catchment modelled from DEM	1 000
7	Kloof catchment 200m buffer	100

8	Gravel patch setback buffer identified in the 2013 EIA	100
9	Fine scale habitat map (see details of ranking below)	10-10 000

		BCI BIODIVERSITY SENSITIVITY RANK			
FINESCALE VEGETATION TYPE	**RANK**	**LOW**	**MEDM**	**HIGH**	**VERY HIGH**
Aggeneys Gravel Vygieveld Mountain Plateau	100			1000	
Aggeneys Gravel Vygieveld Plateau Fine Quartz Gravel Plains	10000				10000
Aggeneys Gravel Vygieveld Plateau Quartz Gravel Plains	1000				1000
Aggeneys Gravel Vygieveld Quartz Gravel Plains	1000			1000	
Aggeneys Gravel Vygieveld Quartz Intermediate Gravel Plains	100	100			
Aggeneys Gravel Vygieveld Rocky Plains	100		100		
Bushmanland Flat Arid Grassland	10	10			
Bushmanland Flat Arid Grassland Calcrete Gravel Plains	10000				10000
Bushmanland Inselberg Shrubland	100		100		
Bushmanland Inselberg Succulent Shrubland	1000			1000	
Kloof	10000				10000
Wash	10		10		

Method:

1. Input layers were clipped to the Area of Interest (i.e. the Gamsberg)
2. Input layers were categorised according to the table above
3. Input layers were unioned into a single shapefile and the ranks for the 9 inputs variables summed to give an overall rank ranging from 10 to 32100 (Figure 3 and Figure 4).

Outputs:

1. Gamsberg_East_Biodiversity_Sensitivity.shp

Projection: UTM34s

9.2 Gamsberg East and South Drill Plan v2 and v3 Impact Area Calculation

Purpose:

The purpose of this analysis is to calculate the area impacted by the proposed draft v2 of the Gamsberg East and South drill plan. The

Input Data:

The following inputs were used:

1. Drill Plan v2 supplied by Alan Johnson on the 6th May 2018:
    a. Gamsberg Tracks Final.shp (line feature)
    b. RSA_GBG_planned_drillholes_May2018_v2.shp (point feature)
2. Gamsberg_East_Biodiversity_Sensitivity.shp
3. Google Earth as background imagery for digitizing tracks
4. Inputs on active tracks from Alan Johnson (Figure 6), Chrizette Neetling and Surveyor General 1:50 000 topographical map form 2003 (Figure 7).

Method:

1. Add access roads to the NE and NW of the supplied drill plan in order to access indicated drill sites/roads at the base of the mountain from setback boundaries. Tracks digitised from Google Earth.
2. Reclassify tracks active/rehab status and those to used in the analysis:
    a. Track field "To Be Used" not to be included in the analysis as "no" (i.e. will not be used):
        i. The existing mine road (i.e. the track up the south of the mountain and into the pit area) as this is an existing mine road irrespective of the prospecting. Impact already factored into the mine assessment.
        ii. All tracks mapped not being used (i.e. not leading to a drill site)
    b. Reclassify all tracks field "Status" that are not access routes as "rehab". On the eastern plateau only the main track from the top of the pass around the eastern plateau to the kloof edge is an active management track. All other tracks should be under rehabilitation.
    c. Reclassify tracks "Status = assumed rehab" as "rehab" to simplify categories in the analysis.
3. Convert the point/line vector drill plan theme to a polygon to remove overlap to eliminate double accounting:
    a. Buffer all tracks "To Be Used = yes" by 2m to create tracks 4m wide
    b. Buffer all drill sites by 8.47m to create a circular drill sites 225m^2. To create rectangular drill pads would require individually digitising each drill pad.
4. Merge drill site and track polygon themes; edit to remove overlaps (double accounting); and, clean topology.

Intersect Drill Site/Track polygon theme with the Biodiversity Sensitivity theme (

5. Figure 5).
6. Export resultant theme table to Excel; add offset ratios based on Biodiversity Sensitivity, land use STATUS and fine quartz patches using the logical steps described in Table 4; and, summarise (Table 5).
7. For DRAFT v3 of the drill plan, return to step 4 above and reclassify selected rehabilitated tracks as active based on discussions with Alan Johnson (Figure 6) and Chrizette Neetling. The logic is that any track mapped that is currently used for monitoring purposes or was present prior to exploration are classified as "active" in terms of their desired land use. All other tracks created since 2003 for the purpose of exploration have the desired land use state/category as "rehabilitated" (Figure 7).
8. Repeat steps 5 and 6. In Excel errors were detected in the calculation of the ratios used in Step 7 for v2. These were corrected and the resultant impact and offset areas between v2 and v3 of the drill plan are compared in Table 5.

Table 4 Description of the logic used to set and modify biodiversity offset ratios for biodiversity features impacted.

Logic Step	Rule Description
1	Set baseline RATIO based on Biodiversity Sensitivity score: 30 if final score>10 000, 10 if 1000<score<10 000, 0 if score <1000.
2	Modify the baseline RATIO based on the land use "Status" field: New = baseline ratio, rehab = move to next offset cat down (i.e. 30 to 10, or 10 to 0), active = 0
3	Modify STEP2 based on mapped presence of fine quartz patches: If status = rehab AND fine QP = yes then baseline ratio reinstated. If status = new AND fine QP = yes then ratio = 0.

Outputs:

1. Gamsberg East Drilling v3 intersect biodiversity sensitivity summary 20180530.xlsx

Projection: UTM34s

Table 5 The area of biodiversity features impacted by drill plan v2 (Figure 5) versus v3 (Figure 7). This table summarises how the offset ratios were assigned based on (1) biodiversity sensitivity (baseline) and modified by (2) land use STATUS and (3) presence of fine grained quartz patches. Green cells indicate where the change in track status from rehabilitated to active has resulted in a change in the total impact area for each row.

Baseline Ratio based on Biodiversity Sensitivity Score	Land Use STATUS	Fine Quartz	Final Modified Ratio	Impact Area (ha)		Offset Area (ha)	
				v2	v3	v2	v3
0	DRILLHOLE_New	0	0	0.1346	0.1346	0	0
0	ROAD_Active	0	0	1.8696	2.5533	0	0
0	ROAD_New	0	0	0.7419	0.7419	0	0
0	ROAD_Rehabilitated	0	0	0.7398	0.056	0	0
10	DRILLHOLE_Existing	0	0	0.7646	0.7646	0	0
10	DRILLHOLE_New	0	10	0.6954	0.6954	6.954	6.954
10	ROAD_Active	0	0	2.4785	3.873	0	0
10	ROAD_New	0	10	0.0515	0.0515	0.515	0.515
10	ROAD_Rehabilitated	0	0	5.5513	4.1569	0	0
30	DRILLHOLE_Existing	0	10	0.0876	0.0876	0.877	0.876
30	DRILLHOLE_Existing	Yes	30	0.0673	0.0673	2.018	2.018
30	DRILLHOLE_New	Yes	30	0.0449	0.0449	1.346	1.346
30	ROAD_Active	0	0	0.4294	0.4294	0	0
30	ROAD_Active	Yes	0	0.421	0.421	0	0
30	ROAD_Rehabilitated	0	10	0.3515	0.3515	3.515	3.515
30	ROAD_Rehabilitated	Yes	30	0.4725	0.4725	14.176	14.176
Total Area (ha)				**14.9014**	**14.9014**	**29.400**	**29.400**

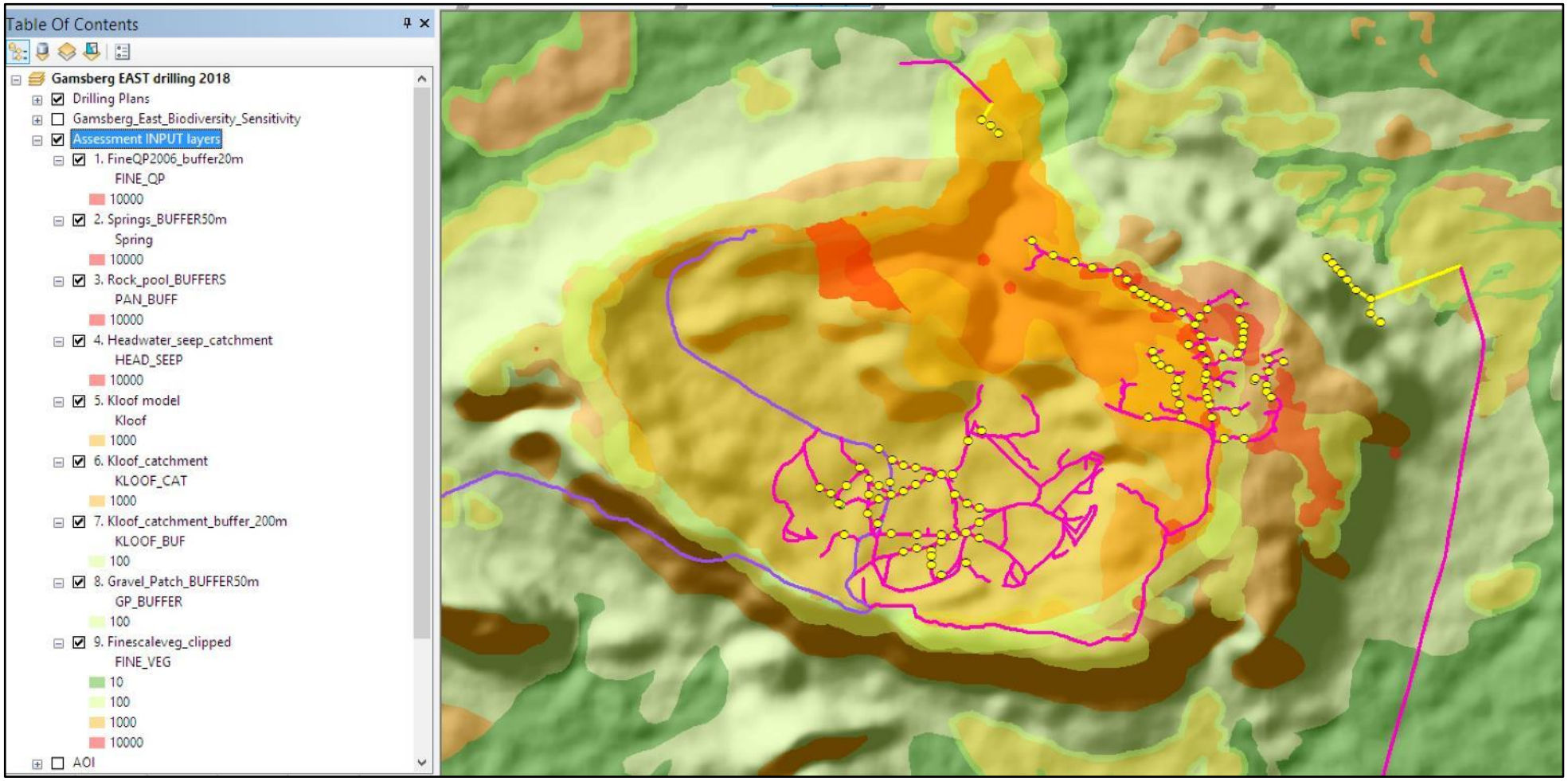

Figure 3 A snapshot of the GIS workspace showing the 9 input variables used in the analysis, their rank scores and overlap relative to the draft v1 proposed drilling sites.

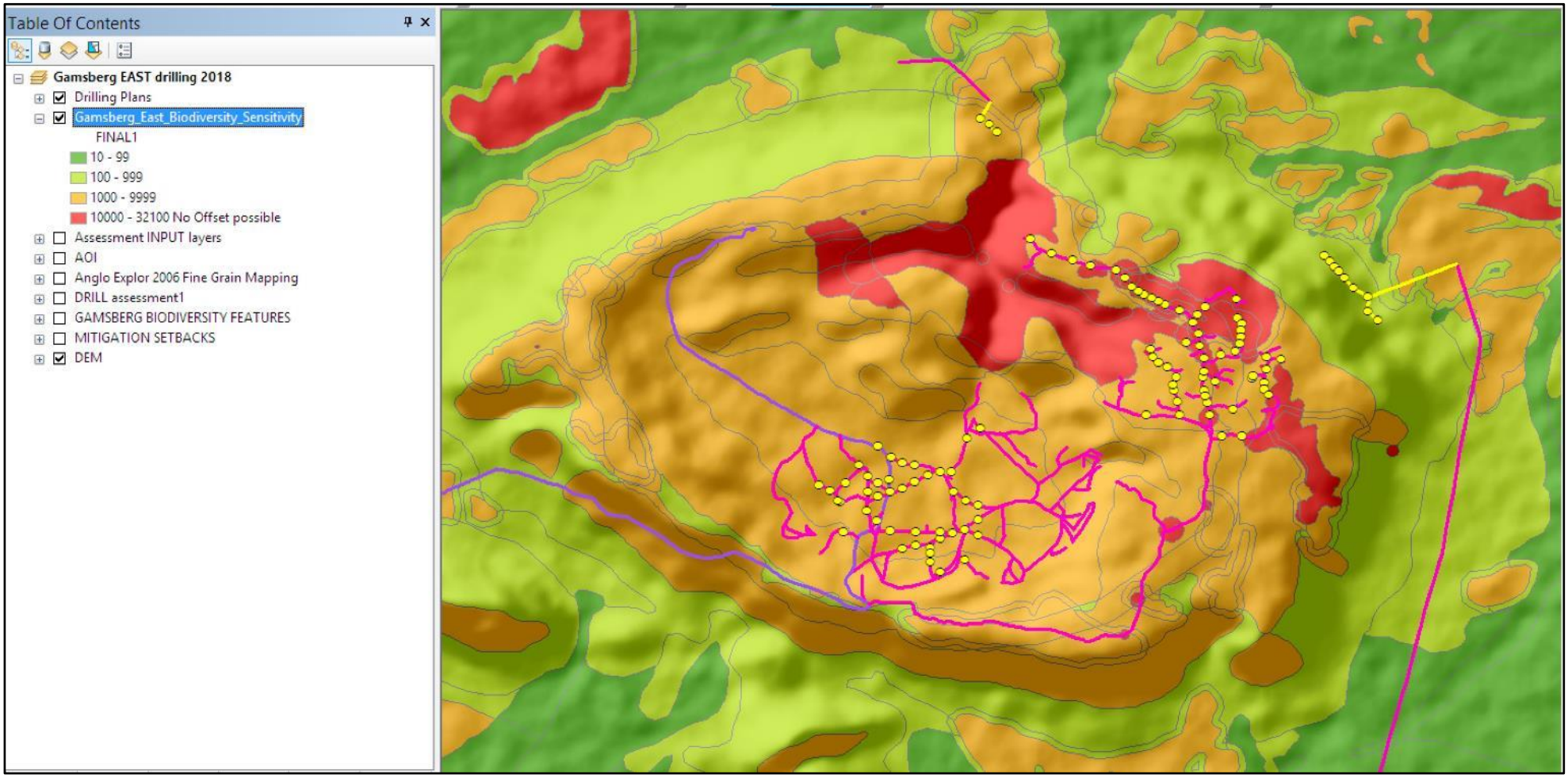

Figure 4 Draft v1 of the proposed drill plan overlaid on the final Biodiversity Sensitivity map. Areas in red indicate summed ranks in excess of 10 000 indicating areas where no offset is possible.

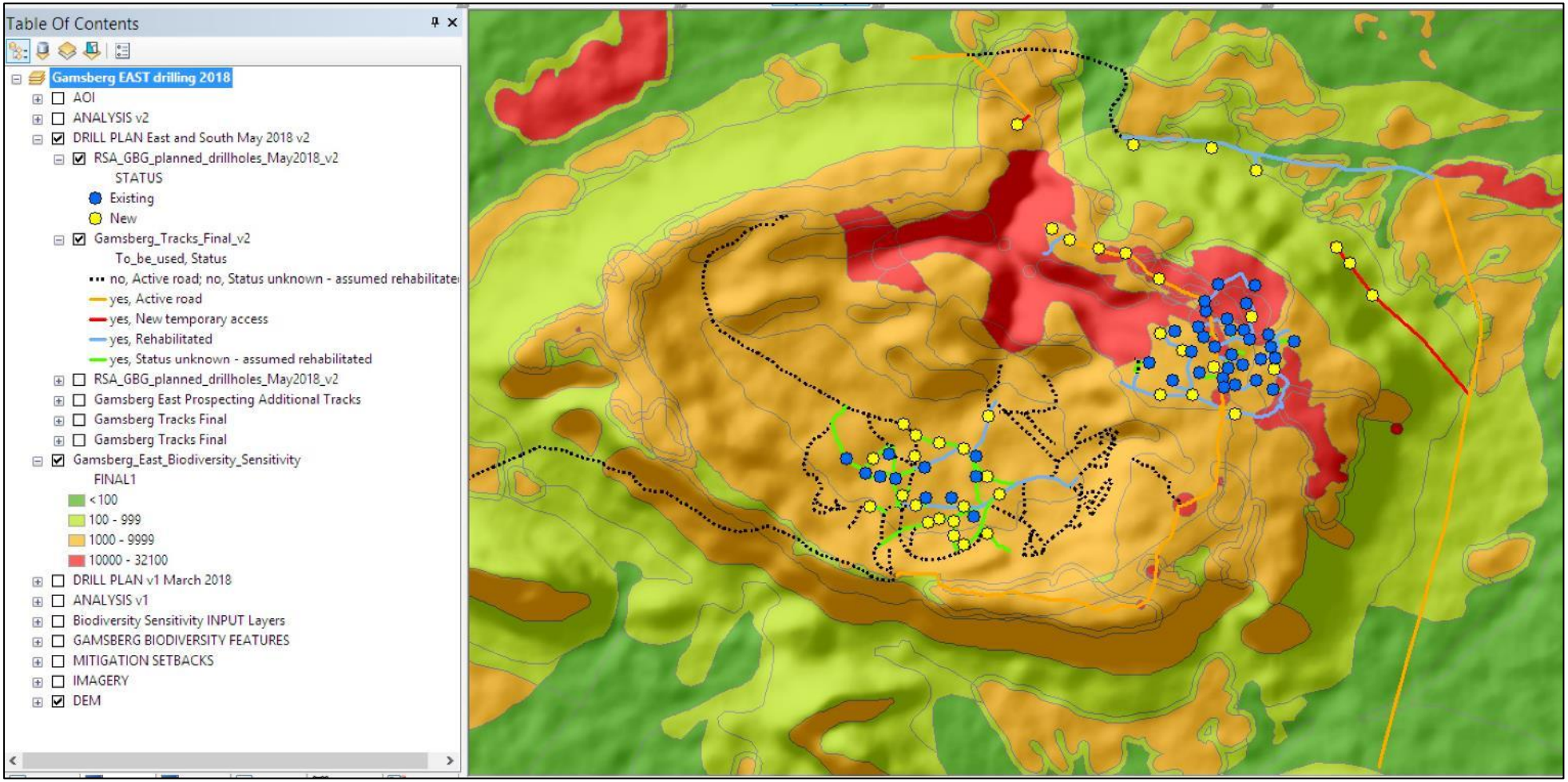

Figure 5 Draft v2 of the proposed drill plan overlaid on the final Biodiversity Sensitivity map.

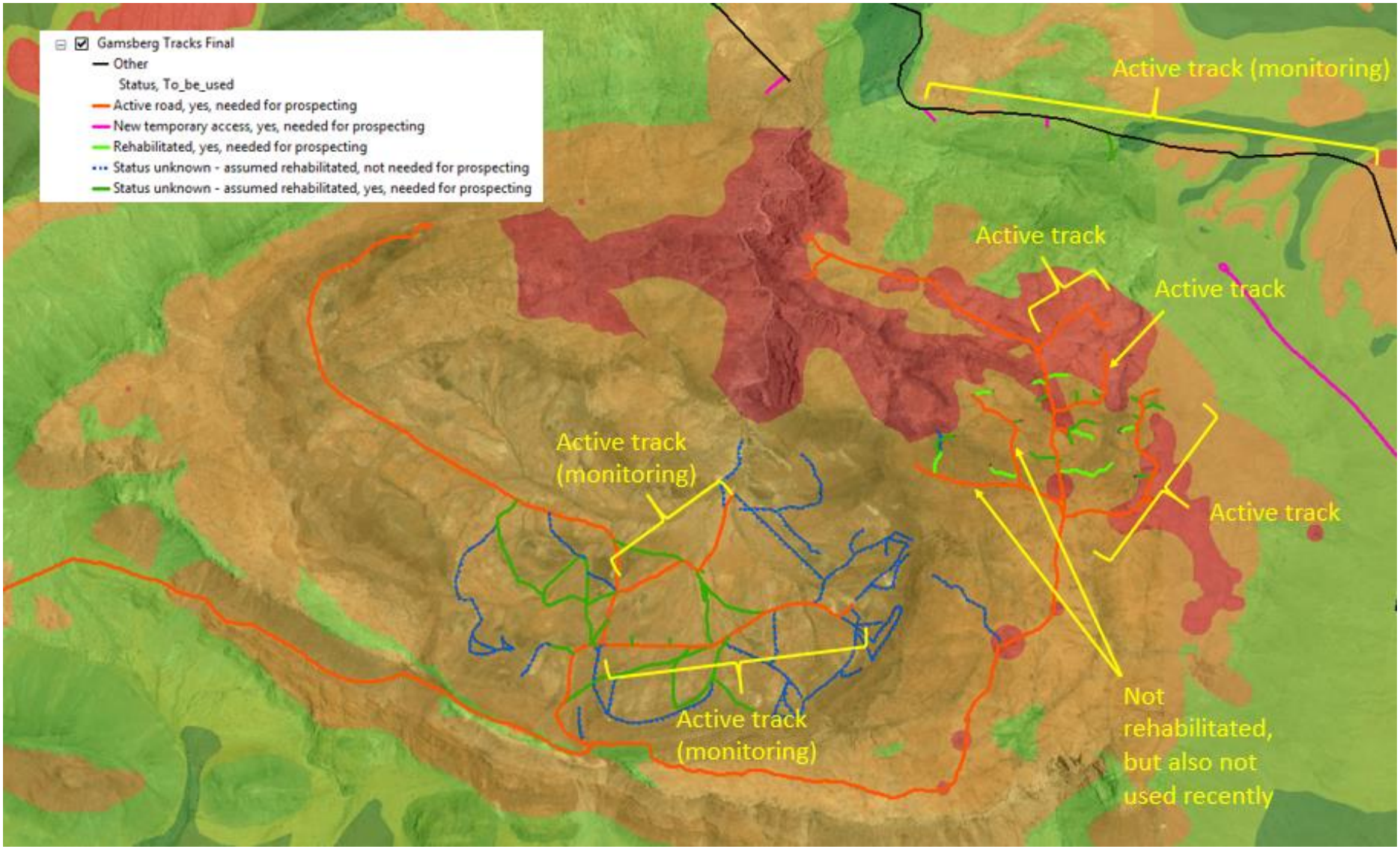

Figure 6 Input from Alan Johnson on what should be considered as active tracks in the offset analysis.

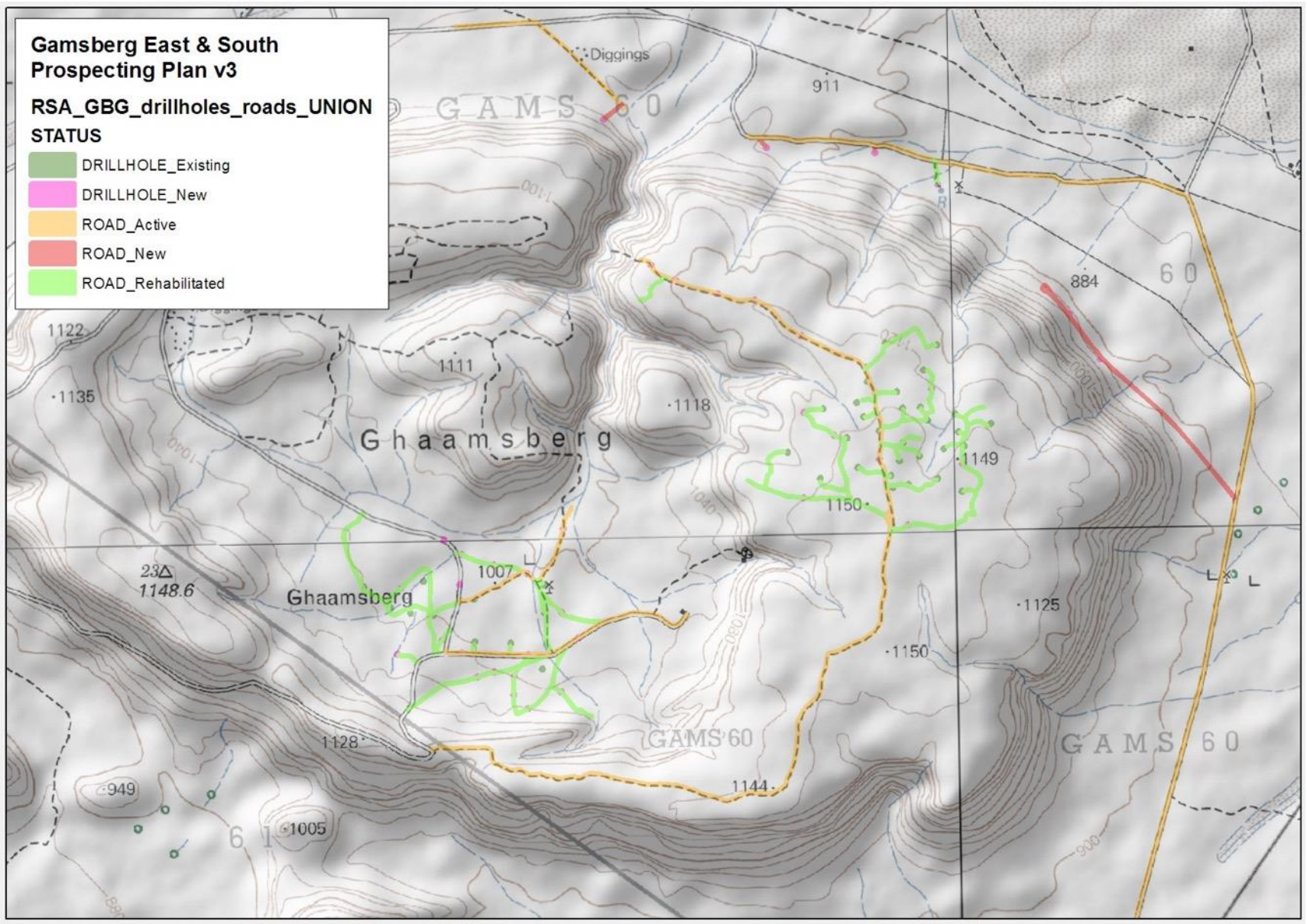

Figure 7 Draft v3 of the proposed drill plan overlaid on the 2003 Surveyor General 1:50 000 topographical map. Note the existing tracks on this topographical map and the change in drill plan track classicisation STATUS to ACTIVE in the basin and NE plains.