Brisbane

2/14 Heussler Terrace
Milton QLD 4064
Australia
www.okc-sk.com

Memorandum

To:	Chris Goti – General Manager - Environment & Heritage, Novo Resources Corp
From:	Andrew Osborn, Senior Scientist
Cc:	Matt Braimbridge – Mine Earth
Our ref:	0999-004-01
Date:	1 June 2021
Re:	**Beatons Creek Gold Project - Conceptual Cover System Design**

Okane Consultants (Okane) have been engaged by Beatons Creek Gold Pty Ltd (BCG) to assist with the development of a conceptual cover system for proposed waste rock dump/s (WRD) that will store potentially acid forming (PAF) material. BCG is a wholly-owned Australian subsidiary of the Novo Resources Corporation (Novo). This memorandum summarises relevant background data provided to, and reviewed by, Okane and recommends a conceptual cover system for the proposed WRD/s.

Background

The Project is located in the East Pilbara region, approximately 2 km west of the Nullagine township and 296 km southeast of Port Headland by road (Figure 1)[1]. Mining in the Project area has occurred for over 100 years with gold first discovered around Nullagine in 1888. Novo's interest in the area commenced in 2015 with the purchase of several Beatons Creek mining leases[1].

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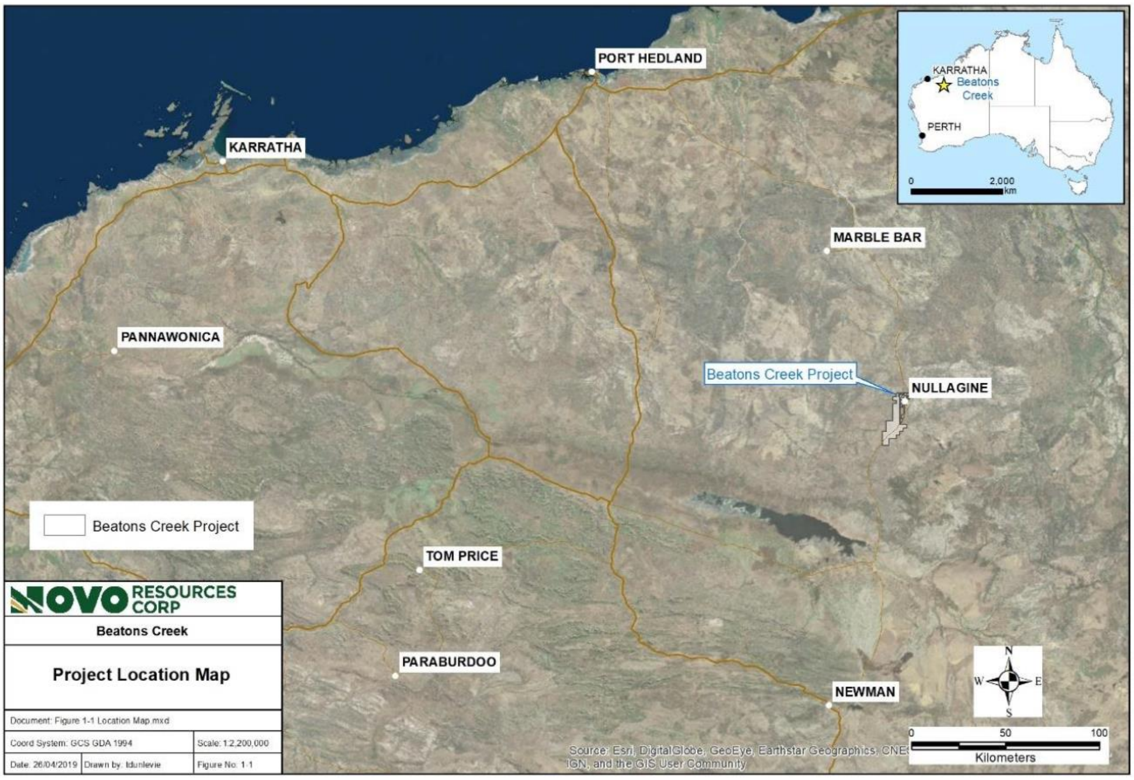
[1] Novo Resources Corp, 2020. Amended and Restated NI 43-101 Technical Report: Mineral Resource Update, Beatons Creek Conglomerate Gold Project, Pilbara Region, Western Australia

The landscape has been described as rugged hills and ridges with stony footslopes and interfluves[2]. According to Novo[1], the project consists of auriferous conglomerate reefs hosted by the Hamersley Basin of late Archaean-Paleoproterozoic age within the East Pilbara granite-greenstone terrain of the Early to Late Archaean Pilbara Craton on the north-western part of Western Australia. The auriferous conglomerates of the Project are hosted by the Lower Fortescue Group sedimentary sequence. The conglomerates occur at different stratigraphic levels in the Fortescue Group within the Nullagine sub-basin, occurring in the mid-to-upper parts of the Hardey Formation.



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES IGN, and the GIS User Community

Figure 1: Project location[1].

BCG is currently seeking approval for mining areas of the Beatons Creek Conglomerate Gold Project (Project) that is expected to generate waste rock classified as PAF[2] and will require specific management to minimise the potential for unacceptable acid and metalliferous drainage (AMD) impacts.

Site Characteristics

An understanding of site characteristics is essential for a cover system design for a PAF WRD. For this conceptual cover system design, the cover system design framework promoted in the INAP Global Cover System Design – Technical Guidance Document (the Guideline)[3] has been adopted. The

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[2] Mine Earth, 2020. Beatons Creek Project – Assessment of the Hydraulic Characteristics of Potential Cover Materials. September.

[3] INAP, 2017. Global Cover System Design – Technical Guidance Document. November.

following four site specific filters from the Guideline have been summarised for the Project site based on the data made available to Okane:

- Climate;
- Hydrogeologic setting;
- Materials; and
- Vegetation.

Climate

According to the Köppen-Geiger climate classification system[4], the climate of the Project is classified as arid, hot desert (BWh). Bureau of Meteorology (BoM) data[5] for the Nullagine Station (approximately 1 km from the Project, Station: 004027) and the Marble Bar/Marble Bar Comparison Stations (approximately 87 km north northeast of the Project, Stations 004106 and 004020 respectively) were used to provide an indication of climate in the region. Data at Nullagine is available for the period of 1897 to 2004 and for the Marble Bar/Marble Bar Comparison Stations from 2000 onwards (Marble Bar) and 1895 to 2006 (Marble Bar Comparison). Based on the BoM data, historical average annual rainfall is 326 mm at Nullagine and 403/358 mm at the Marble Bar/Marble Bar Comparison Stations, respectively. Rainfall is highest between December and March, when infrequent, high intensity events can occur, and lowest from April to November (Figure 2). Annual average pan evaporation is 3,321 mm at the Marble Bar Comparison Station. Potential evaporation (PE) is estimated to be approximately 2,200 on average. PE exceeds rainfall for every month of the year, with the smallest evaporation to rainfall ratio of 3:1 occurring in both January and February (Figure 3).

Future Climate

Climate projections developed by the CSIRO[6] to support the planning needs of the Australian natural resource management sector suggest the Project area should expect:

- Average temperatures to continue increasing in all seasons;
- More hot days and warm spells;
- Changes to rainfall patterns, however the nature of the changes are unclear; and

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[4] Peel, M., Finlayson, B.L., and McMahon, T.A. 2007. Updated world map of the Köppen-Geiger climate classification. Hydrology and earth system sciences discussions, 4(2), 439-473.

[5] http://www.bom.gov.au/climate/data/, accessed 9 March 2021.

[6] https://www.climatechangeinaustralia.gov.au/en/climate-projections/future-climate/regional-climate-change-explorer/sub-clusters/?current=RLNC&tooltip=true&popup=true, accessed 9 March 2021.

- Increased intensity of extreme rainfall events.

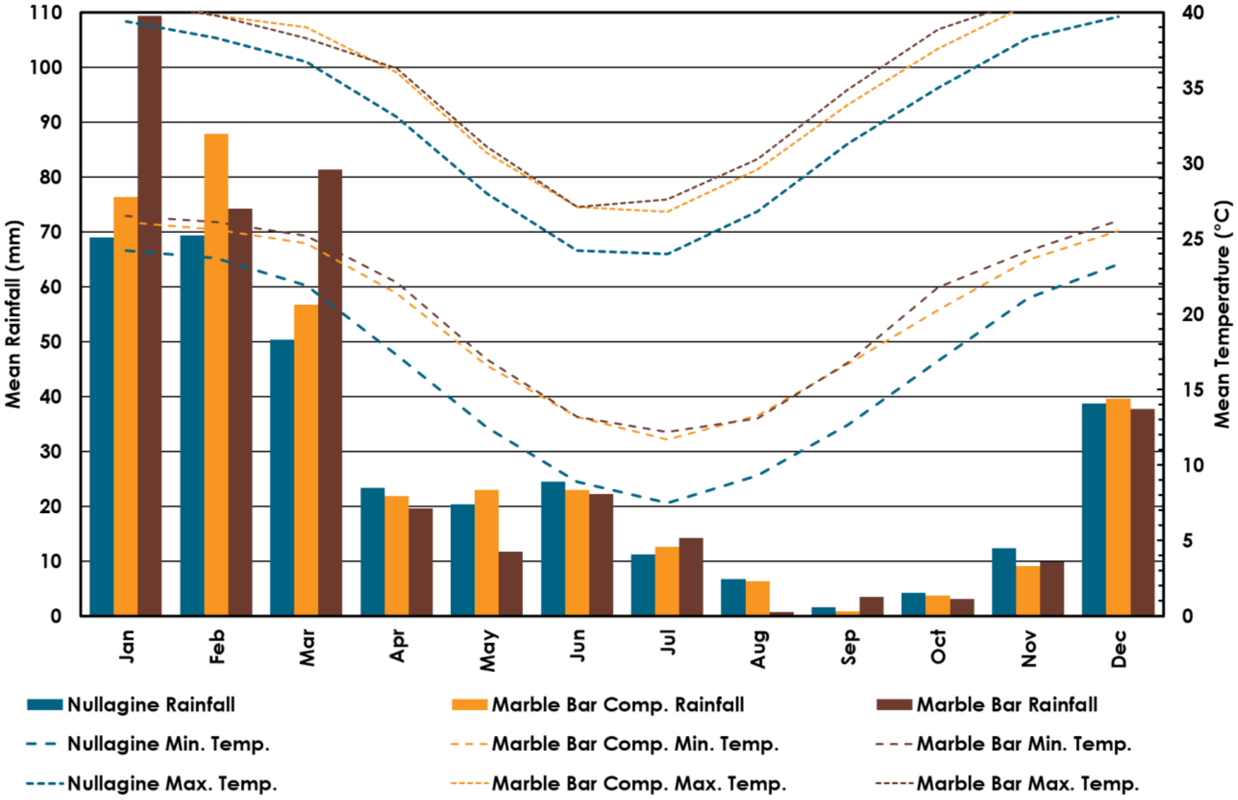

Figure 2: **Project Climate**[5].

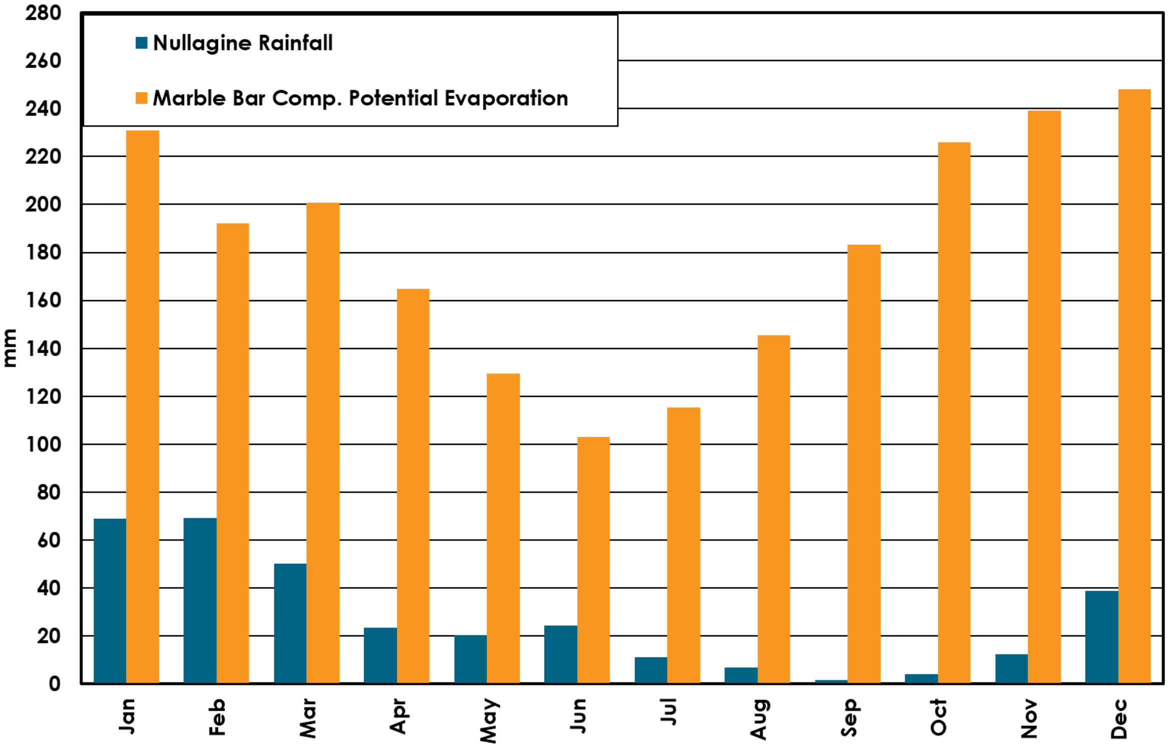

Figure 3: Evaporation against rainfall[5].

Hydrogeology

The Project lies within a Priority One Public Drinking Water Source Area. According to DWER, Priority 1 (P1) areas are "defined and managed to ensure there is no degradation of the quality of the drinking water source with the objective of risk avoidance"[7]. Based on previous assessment of aquifer conditions at site, Novo has concluded there is no existing groundwater connection between the Fresh Rock mining area and the drinking water supply bores near site. Post mining groundwater is expected to result in a cone of groundwater depression extending out from the final void and encompassing the mining lease, including the ex-pit WRD. A final void pit lake is predicted post-closure and is modelled to result in a terminal sink for groundwater generated from within the cone of depression. Seepage generated from the ex-pit WRD is modelled to flow to the pit voids.[8].

Materials

Mine waste from the Project was assessed and characterised by SRK (2015; 2018) and Graeme Campbell and Associates (GCA, 2020). Mine Earth have summarised the results of this work as follows[2]:

- The upper portion of the oxide profile has been classified as non-acid forming (NAF). The NAF oxide zone exhibits sub-neutral pH (5-6), Al forms that are strongly bound to clays and modest enrichments in As, Sb, Se and Bi which demonstrate low solubility.
- The lower portion of the oxide profile has been classified as 'alunitic oxide'. The alunitic oxide zone exhibits acidic pH (4-5), exchangeable Al on clays, a potential source of soluble Al and acidity (governed by salinity) and modest enrichments in As, Sb, Se and Bi which demonstrate low solubility.
- Fresh conglomerate has been classified as PAF. Fresh conglomerate is typically characterised by Pyrite-S values in the range of 1-3% and groundmass devoid of carbonates. Fresh conglomerate is characterised by modest enrichments in As, Sb and Se.

GCA[9] concluded the following implications apply to the waste materials generated by the Project:

- NAF oxide has no special management requirements from a geochemical perspective and can be placed on the final surface of constructed landforms including WRDs.

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[7] DWER, 2016. Water quality protection note no. 25. Land use compatibility tables for public drinking water source areas. April.

[8] Beatons Creek Fresh Rock Mining Approvals Team, 2021. Project Meeting, 25 February 2021, online.

[9] GCA, 2020. Beatons Creek Gold Project – Geochemical assessment of mine-waste samples from the oxide-waste-zone and implications for mine-waste management. Unpublished report prepared by Graeme Campbell and Associates (GCA) for Beatons Creek Gold Pty Ltd. Dated 3 September 2020. (Sourced from Mine Earth 2020[2])

- Alunitic oxide should not reside on the final surface of constructed landforms and should be covered with a nominal 2 m cover of NAF oxide. The objective is to broadly reconfigure the natural oxide profile of NAF oxide overlying alunitic oxide. Alunitic oxide can be used to construct WRD lifts upon which PAF cells will be constructed and can be used as part of a cover over a PAF cell provided that it is covered with NAF oxide.

- PAF rock should be isolated within engineered PAF cells to minimise the potential for acidification via infiltration control.

Table 1 provides the waste rock volumes currently expected to be generated by the Project.

Table 1: Waste Rock Volumes[10]

Material	bcm	~%
Alunitic-oxide	8,966,011	28
NAF-oxide	8,248,668	26
PAF waste rock	14,470,931	46

Site available materials identified as potential cover system construction materials during a material characterisation program undertaken by Mine Earth[2] were limited to the following:

- Conglomerate oxide (both alunitic oxide and NAF oxide);
- Mosquito Creek Formation; and
- Tuff.

Okane understand that whilst the Mosquito Creek Formation material displays favourable physical properties, the overall available quantity of this material is expected to be insufficient to be considered a practical resource for cover system design. The Mosquito Creek Formation material is not considered further in this memorandum. Following sample collection, Mine Earth determined the Tuff was too coarse, blocky and durable to be considered as a potential source for a store-and-release or barrier layer within a cover system. As such the Tuff was not subjected to laboratory work and is also not considered further in this memorandum. However, the Tuff may still hold value for a cover system as an erosion control material used in concentrated drainage paths or as a rock armour layer on cover system surfaces.

Key physical and chemical properties of the conglomerate oxide (NAF), as reported by Mine Earth, are presented in Table 2 to Table 7. However, it should be noted, much of the testing was completed on material passing the 4.75 mm sieve, in accordance with standard soil and geotechnical testing methods. As such, the results reproduced in this memorandum, when considered in isolation,

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[10] Goti, C., 2021. Email to Graeme Campbell, Andrew Osborn and Shannon Mackenzie, 26 February.

discount the influence of the rock sized particles that make up a majority (>70%) of the sampled material. This was acknowledged, and the potential influence discussed, in the Mine Earth report[2].

Table 2: Average Particle Size Distribution (PSD)[2]

Material	Ave % Rock (>4.75 mm)	Ave PSD of <4.75 mm fraction		
		% sand	% silt	% clay
Conglomerate oxide (NAF)	73	74	9	17

Table 3: Physical Charateristics[2]

Material	Physical Characteristics <4.75 mm fraction				
	Standard MDD* (t/m³)	Emerson Class	Liquid Limit (%)	Plastic Limit (%)	Linear Shrinkage (%)
Conglomerate oxide (NAF)	2.01	Class 6**	30.3	14.6	7.3

* Maximum dry density

** Aggregate slakes, but no dispersion, no dispersion of remoulded soil, flocculation of a 1:5 soil:water suspension.

Table 4: Average Saturated Hydraulic Conductivity (K_{sat}) Laboratory[2]

Material	Fraction (mm)*	K_{sat} (cm/s)			
		Loose**	80% MDD⁺	Compacted⁺⁺	95% MDD#
Conglomerate oxide (NAF)	<4.75	6e-3	1.9e-3	1e-3	1.2e-5
	<25	8.9e-3	3e-3	4.9e-4	-
	<50	1.4e-4	7.7e-3	-	-

* Bulk samples of Conglomerate oxide sieved to 4.75 mm, 25 mm and 50 mm.

** Loosely tipped sample with no external compaction.

⁺ Compacted to approximately 80% of MDD.

⁺⁺ Maximum achievable compaction in large columns.

\# <4.75 mm sample compacted to 95% of MDD.

Table 5: Average Saturated Hydraulic Conductivity (K_{sat}) Field

Material	Location	K_{sat} Range (cm/s)	Ave K_{sat} (cm/s)
Conglomerate oxide (NAF)	Trial Mining Area (4 locations)	3.8e-7 to 2.6e-6	1.6e-6

Table 6: Water Retention Characteristics[2]

Material	<4.75 mm fraction		
	Field Capacity / Upper storage limit (USL) (% vol.)*	**Lower storage limit (LSL) (% vol.)***	**Plant available water (PAW) content (% vol.)****
Conglomerate oxide (NAF)	14.8	8.0	6.8
	16.1	10.0	6.1
	14.9	8.0	6.9

* USL taken as 10 kPa (0.1 bar), LSL taken as 1,500 kPa (15 bar). Approximate % volumetric water content at 1,500 kPa derived from water retention curve (GCA, 2020).

** PAW of whole material (i.e. including coarse fraction >4.75 mm) will be lower.

Table 7: Average Chemical Characteristics[2]

Material	EC (1:5 soil:water) (dS/m)	pH (1:5 soil:water)	Exchangeable cations					Plant-available nutrients (mg/kg)				
			eCEC (cmol/kg)	%Na (ESP)	%Mg	%Ca	%K	Amm. N	Nit. N	P	K	S
NAF-oxide Surface	0.014	6.20	4.1	2.7	36.0	36.7	25.0	1.5	3.0	<2	91	6
NAF-oxide Deep	0.222	5.10						1.8	1.0	<2	124	170
Alunitic-oxide Deep	0.203	5.28						1.8	1.3	<2	109	131
NAF-oxide Backfill	0.068	6.58						1.8	7.0	<2	87.6	73
Alunitic-oxide Backfill	0.248	4.53						2.8	4.8	<2	70	266.8

Vegetation

Vegetation in the region is considered relatively sparse with a Spinifex groundcover, scattered Hakea, Acacia and Grevillia shrubs and larger Eucalyptus and Melaleuca trees confined to the immediate vicinity of drainage paths[1]. During the material sample program, Mine Earth reported vegetation regrowth on the Trial Mining Area as sparse but relatively healthy and diverse[2]. Okane understands the influence of vegetation has not yet been considered. Whilst this is a reasonable position to take, it does represent a conservative position. Any vegetation regrowth that establishes on the cover system will have a positive influence on NP rate performance.

Conceptual Cover System Design

Waste Rock Dumps

It is understood PAF waste rock is currently proposed to be stored in both an ex-pit WRD and an in-pit WRD. The ex-pit WRD will be positioned to the north east of the pit and constructed over areas of fresh conglomerate exposed during the oxide mining project.

The in-pit WRD will be positioned within the final void, largely below the pit crest, with pit lakes modelled to form either side following the cessation of mining. Modelling indicates the pit lakes will act as a terminal sink for seepage and groundwater within the cone of depression created by the final void. PAF waste rock in the in-pit WRD is proposed to be stored both below the minimum modelled seasonal water level, and above the maximum modelled seasonal water level within the final void. An ephemeral drainage channel will be constructed across the in-pit WRD to allow surface waters to traverse the final void in a manner similar to that of pre-mining conditions.

The same conceptual cover system design is proposed for both the ex-pit WRD and the in-pit WRD, where above the minimum modelled seasonal water level of the pit lakes.

Proposed Cover System Purpose and Objective

A cover system is proposed as one of three AMD control mechanisms alongside the use of strategic waste placement techniques (such as low lift heights and targeted traffic compaction) and siting the facilities in locations where seepage will be directed towards the final void, modelled to behave as a terminal sink for groundwater. The three AMD control mechanisms can be viewed through the typical source-pathway-receptor model. Strategic waste placement techniques aim to reduce the rate of sulfide oxidation in the PAF waste material and therefore restrict the generation of stored acidity (source). The purpose of the cover system is to reduce net percolation (NP) and restrict the pathway. The void, acting as a terminal sink, is the receptor, which may prove to be less sensitive to water quality than other, offsite, receiving environments. When considering the cover system as one of three AMD control mechanisms adopted for the WRDs, it should not be designed, nor should performance targets be nominated, in isolation from the other two control mechanisms.

The objective for the conceptual cover system design proposed for the Project's PAF WRDs is to reduce the infiltration of rainfall to depth below the cover system where it can no longer be removed by evapotranspiration, referred to as net percolation (NP), into the WRDs whilst supporting preferred vegetation communities and limiting erosion. The degree of NP reduction proposed for the cover system should be closely coupled to the anticipated reduction in oxidation achieved through strategic waste placement techniques.

Performance Target

Considering the purpose and objective of the cover system is to restrict the 'pathway' by reducing NP, the proposed performance target for the cover system is to:

- Achieve a moderate NP rate (5-10% annual rainfall)[3] on average and 80% of the time for any given year.

This target acknowledges the cover system is not the sole control, but one of three key AMD control mechanisms. It also takes into consideration the regional climate whereby infrequent, but not unexpected, high intensity rainfall events occur. It is anticipated that for most of the time, the proposed cover system would achieve an NP rate in the low to very low range (<5%)[3]. However, in order to maintain this NP rate following a typical, high intensity event would likely require a barrier type cover system. A barrier type cover system would require suitable materials be imported (i.e., clays, geosynthetic materials, geomembranes) and result in a level of performance improvement that is unlikely to be justified against the significant additional costs of constructing such a system on the scale required.

Proposed Conceptual Design

The material available to construct a cover system over the necessary surface area appears to be limited to the conglomerate oxide. Material balances (Table 1) suggest there will be adequate volumes of conglomerate oxide for the proposed design. Okane understands the volume of Mosquito Creek Formation material anticipated to be available is not expected to be sufficient to construct a layer with an effective depth within the cover system. Whilst the laboratory results for saturated hydraulic conductivity (K_{sat}) indicate the conglomerate oxide samples have a relatively high permeability, the *in situ* field results from the backfilled, 2016 Mining Area, are more promising and potentially more representative of the as-mined material that would be used to construct a cover system. Okane also understand waste rock from a neighbouring operation maybe available for use. We support investigating this source and determining if it has value for use as a cover system material.

The proposed conceptual cover system design for the Project adopts the moisture store-and-release principle as the primary mechanism by which to reduce NP into the underlying waste material. The store-and-release cover system reduces NP by storing most infiltrating water within the evapotranspiration zone of the cover system so that water can be subsequently released to the atmosphere via transpiration and/or evaporation.

In Okane's experience, and considering the material properties of the conglomerate oxide, the regional climate and the fact the cover system will be one of three AMD control mechanisms adopted, a simple store-and-release cover system will likely to be a suitable cover system configuration to achieve the proposed performance target. The conceptual cover system design for the Project's WRD comprises (from surface down) (Figure 4):

- Topsoil layer. The depth of the topsoil layer will be dependent on the volumes available for recovery prior to mining. It is understood topsoil available for recovery is limited to absent. In this case, topsoil may be used sparingly to create seedbank islands from which colonisation of other, non-topsoiled areas, can occur.

- Store-and-release layer. The store-and-release layer will be 1-2 m thick and constructed using conglomerate oxide. NAF oxide will be used at the surface to support vegetation growth. Nominally, a minimum of 0.5 m of NAF oxide will be required, however this depth can be revised based on the results of ongoing rehabilitation field trials, an understanding of the rooting behaviour of target revegetation species and learnings gained from the revegetation that had established on the 2016 Mining Area. The remaining depth of the store-and-release unit will comprise Alunitic oxide or NAF oxide. Optimisation modelling of the store-and-release layer will be undertaken once as-mined material is available for sampling. A reduction in depth may be possible. However, an increase in depth beyond 2 m is considered unlikely to improve NP rates.

Should cover system optimisation modelling, using as-mined material properties as inputs, indicate the proposed cover system design will not achieve the desired performance outcomes, several enhancements have been identified to improve performance. An enhanced store-and-release cover system uses the same primary mechanism as the store-and-release system and would be supported by a lower permeability layer within the system to provide further control following high intensity events during which the cover system storage capacity would be exceeded. Potential enhancements that could be considered, and which would be relatively easily incorporated into the proposed design, include:

- Compacting layer/s of the oxide during construction to further reduce permeability;

- Strategic use of other materials with limited availability but lower permeability (e.g., Mosquito Creek Formation or AU81 material) in areas where increased NP is likely to occur. For example, the top surface could be designed to retain rainfall in designated areas where the cover system has been enhanced with a lower permeability layer; and

- Sourcing and incorporating imported materials, more generally, into the cover system to further reduce permeability.

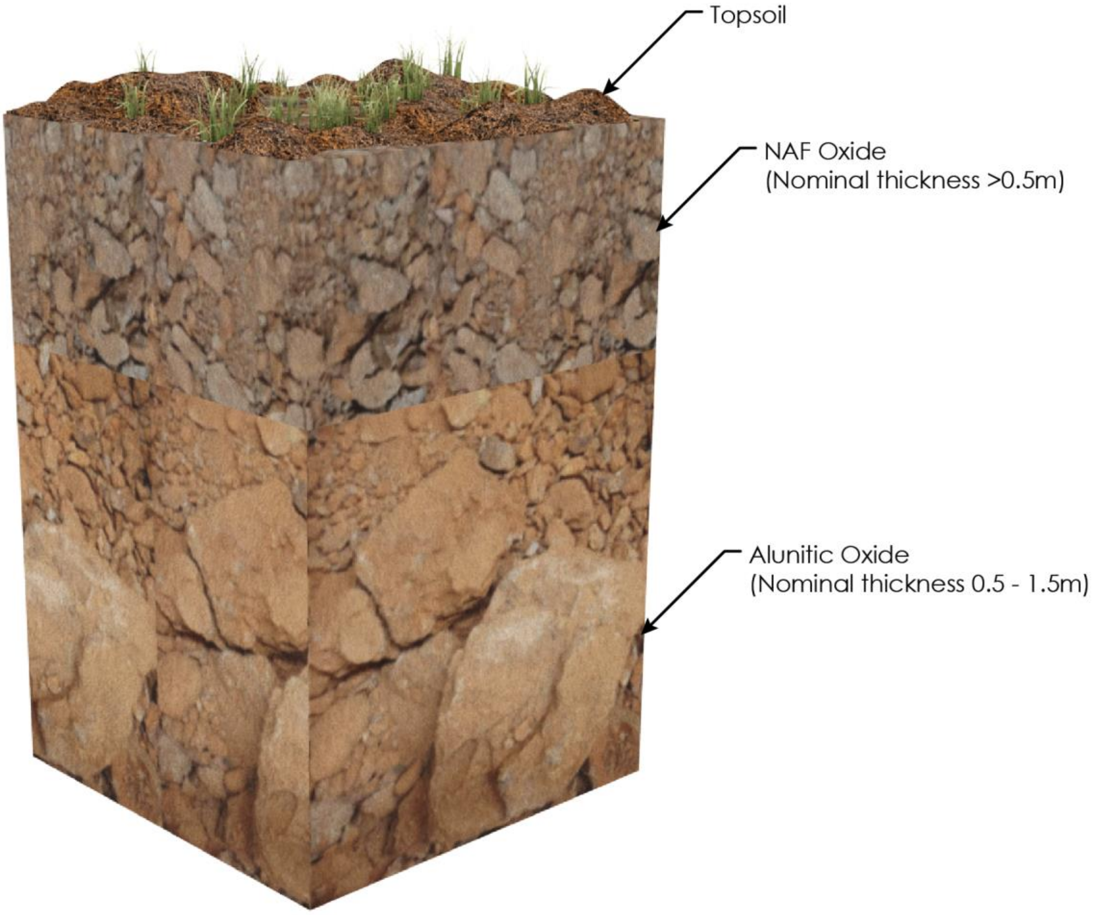

Figure 4: **Conceptual cover system for BCGP WRDs.**

We trust information provided in this memorandum is satisfactory for your requirements. Please do not hesitate to contact me at 0403 062 682 or aosborn@okc-sk.com should you have any questions or comments.