The mine closure specialists

BEATONS CREEK FRESH ROCK PROJECT

CONCEPTUAL LANDFORM CLOSURE DESIGN

FEBRUARY 2022

MINE EARTH
Unit 1, 94 Forsyth St
O'Connor WA 6163

+ 61 8 9431 7318
info@mineearth.com.au
www.mineearth.com.au

100% of Mine Earth's carbon footprint has been voluntarily offset by the planting of native trees

Mine Earth Pty Ltd (ACN 141 633 696)

Author	Checked	Distribution	Date	Version
S. Mackenzie E. Smedley M. Braimbridge	S. Mackenzie M. Braimbridge	C. Goti	20 February 2022	Revision A
S. Mackenzie	F. Jones (360 Environmental)	C. Goti	22 February 2022	Revision B

TABLE OF CONTENTS

Figures

Tables

1 INTRODUCTION

Beatons Creek Gold Pty Ltd (BCG) is an Australian subsidiary company of Novo Resources Corporation (Novo). BCG is proposing to expand its Beatons Creek paleoplacer gold project (the Project) from oxide only mining, to include fresh rock mining. The Project is located near the township of Nullagine in Western Australia's Pilbara region.

Mine Earth has been involved in the Project since 2015 and has worked in close collaboration with Novo personnel and their consultants (Graeme Campbell and Associates, SRK, Okane Consultants, 360 Environmental and Auralia Mining Consultants) to develop conceptual landform closure designs for both the oxide and fresh rock Projects.

This report presents the agreed conceptual landform closure designs for the fresh rock Project. The report is structured as follows:

1. Introduction
2. Landform design inputs
3. Landform design requirements
4. Landform design parameters
5. Conceptual landform design
6. Soil inventory
7. Forward work plan

1.1 Project area description

The Project is located approximately 2 km northwest of the township of Nullagine. The Project is located within the Capricorn Land System and the local landscape is characterised by rugged hills and ridges with stony footslopes and interfluves (Figure 1) (DPIRD 2020b). Gold was first discovered near Nullagine in 1886 and the area has a long history of mining. The area has been subject to considerable historical ground disturbance through the late 1980s and early 1990s.

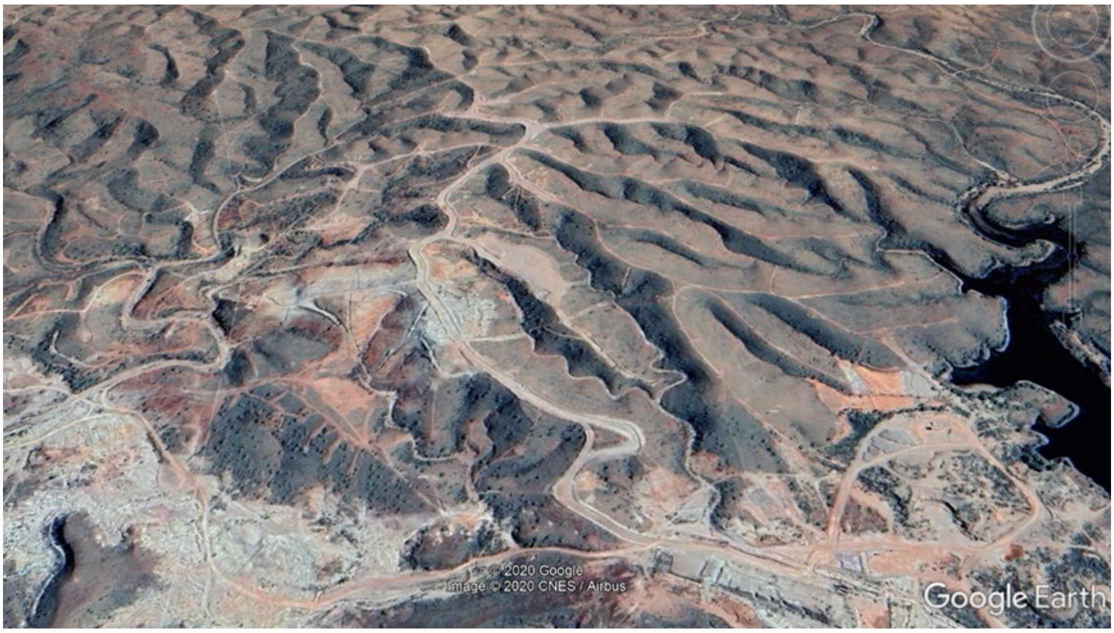

Figure 1 Project area (Google Earth 2020)

2 LANDFORM DESIGN INPUTS

The key inputs for the development of the conceptual landform closure design are outlined in this section under the headings:

- Geology
- Geochemistry
- Waste rock management
- Waste rock proportions
- Erosional stability
- Waste rock drainage properties
- Hydrogeology
- Surface hydrology
- Climatic conditions

2.1 Geology

The Beatons Creek deposit consists of auriferous conglomerate reefs hosted by the Lower Fortescue Group; a sedimentary sequence located within the Nullagine basin, part of the Archaean-Palaeoproterozoic Hamersley Basin. The auriferous conglomerates occur at different stratigraphic levels in the mid to upper parts of the Hardey Formation (within the Fortescue Group). The stratigraphy at the deposit is a sequence that ranges from the Beatons Upper unit, through Lag, Beatons Middle and Beatons Lower units, to the basal Beatons Granulestone. These units are predominantly pebble to cobble conglomerates with occasional boulder horizons. Some sandstones and tuffs are interbedded with some of these units (Novo 2019a).

Gold mineralisation occurs within the conglomeritic Beatons Creek Member of the Hardey Formation. Gold is present as fine to coarse particles within the matrix of multiple, narrow ferruginous-conglomeritic reef horizons (up to 2 km in extent) that are interbedded with unmineralised conglomerate, sandstone and granulestone/grit, intercalated with minor shale, mudstone, siltstone and tuff (Novo 2019a).

The Fortescue Group unconformably overlies the Mosquito Creek Formation along much of the northeast margin of the Nullagine sub-basin (within which the Project is located) (Novo 2019b). The Mosquito Creek Formation at the project typically contains sandstone, mudstone, shale and conglomerate units (Novo 2019b).

The key waste rock lithology types to be generated during mining at the Project, including their estimated relative proportions, include (Novo pers. comm. 2022):

- Conglomerate (~90% of the total waste rock volume)
- Tuff (~5% of the total waste rock volume)
- Mosquito Creek Formation (~5% of the total waste rock volume)

2.2 Geochemistry

Assessments of waste rock geochemistry have been undertaken for the Project by SRK (2015; 2018) and Graeme Campbell and Associates (GCA 2020a; 2022). The geochemical characteristics of waste rock from the Project waste rock can be summarised as follows:

- The upper portion of the oxide profile has been classified as non-acid forming (NAF) (GCA 2020a). 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' (GCA 2020a). 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. GCA (2020) concluded that alunites and sulphate salts (mainly $MgSO_4$) occur pervasively throughout the oxide zone; due to excess sulphate salts and the 'common-ion' effect in the presence of water, alunites are stabilised and do not typically dissolve.
- Fresh conglomerate has been classified as potentially-acid forming (PAF) (GCA 2020a; SRK 2018). 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.

2.3 Waste rock management

The following implications for waste rock management apply (GCA 2020a):

- NAF-oxide has no special management requirements from a geochemical perspective and can be placed on the final surface of constructed landforms including waste rock dumps (WRD).
- Alunitic-oxide should not reside on the final surface of constructed landforms and should be covered with 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 PAF cells to minimise the potential for acidification via infiltration control.

2.4 Waste rock proportions

The estimated volumes and proportions of NAF-oxide, alunitic-oxide and PAF to be generated from the Project are (including allowance of a 1.3 swell factor) (Novo pers. comm. 2022):

- 8.6 million loose cubic meters (Mlcm) of NAF-oxide (21.1% of the total waste rock volume).
- 13.4 Mlcm of alunitic-oxide (32.9% of the total waste rock volume).
- 18.7 Mlcm of PAF (46% of the total waste rock volume).

2.5 Erosional stability

Pendragon (2015) assessed the physical and chemical properties of surface soils and sediment from the Project area in 2015. Mine Earth assessed the erosional stability properties of grab samples of conglomerate/NAF-oxide waste rock from the Project in 2017 (Mine Earth 2017) and in 2018 Mine Earth assessed the erosional stability properties of a bulk sample conglomerate/NAF-oxide waste rock (Mine Earth 2018).

2.5.1 Conglomerate-oxide/NAF-oxide

Mine Earth (2018) assessed the erosional stability of a bulk sample of conglomerate/NAF-oxide using flume testwork and WEPP (Water Erosion Prediction Project) modelling outputs to define the optimal landform configuration (slope length, gradient and height) for Project WRDs. The bulk sample was collected from a stockpile of as-mined waste rock from Novo's pilot mining area; this stockpile was considered by Novo's geologists to be representative of typical conglomerate/NAF-oxide waste rock to be mined from the Project (Mine Earth 2018).

Simulated rainfall, overland flow and settling column studies were undertaken on the bulk sample to assess the effective hydraulic conductivity, interrill erodibility, critical shear for rill initiation, rill erodibility, and particle size distribution and density. These parameters were applied as inputs for WEPP to model long-term erosion for linear and concave WRD slopes (Mine Earth 2018). Slope configurations with simulated mean annual average erosion rates of <5 t/ha/yr and mean annual peak erosion rates of <10 t/ha/yr were assumed to represent acceptable threshold values for the assessment. These nominal thresholds are conservative and should not be applied as absolute targets for erosion stability, they should only be used as a guide to inform landform design (Mine Earth 2018).

The WEPP results indicated that linear WRD slopes could be constructed to a maximum lift height of 15 m before the nominated erosion thresholds were exceeded (for both 18˚ and 20˚ slopes) (Table 1) (Mine Earth 2018). The WEPP results indicated however, that stable slopes (that remained below the nominated erosion thresholds) could be constructed for 20 m, 25 m and 30 m lift heights by adopting a concave slope profile (Table 2).

Table 1 WEPP simulation results for linear WRD slopes (Mine Earth 2018)

Vertical Height (m)	Batter Gradient (°)	Batter Gradient (%)	Horizontal Footprint (m)	Slope Length (m)	WEPP-Predicted Mean Annual Erosion Rates (t/ha/y)	
					Average	Peak
8	18	32.5	24.6	25.9	0.3	1.8
8	20	36.4	22.0	23.4	0.3	2.0
10	18	32.5	30.8	32.4	0.6	3.7
10	20	36.4	27.5	29.2	0.7	4.0
15	18	32.5	46.2	48.5	2.1	9.4
15	20	36.4	41.2	43.9	2.3	9.9
20	10	17.6	113.4	115.2	2.1	9.4
20	18	32.5	61.5	64.7	4.1	15
20	20	36.4	54.9	58.5	4.3	16
25	8	14.1	177.9	179.6	2.3	9.6
25	18	32.5	76.9	80.9	6.2	21
25	20	36.4	68.7	73.1	6.6	22
25	25	46.6	53.6	59.2	7.2	23
30	7	12.3	244.3	246.2	2.3	9.1
30	18	32.5	92.3	97.1	8.3	26
30	20	36.4	82.4	87.7	8.9	27
30	25	46.6	64.4	71.0	9.6	29

Table 2 WEPP simulation results for concave WRD slopes (Mine Earth 2018)

Horizontal Footprint (m)	Vertical Height (m)	Gradient (°)	Gradient (%)	WEPP-Predicted Mean Annual Erosion Rates (t/ha/y)	
20m Vertical Height					
0-41	20-5	20	36.4	3.1	10
41-59	5-0	16	28.7		
25m Vertical Height					
0-41	25-10	20	36.4	3.2	8.5
41-59	10-5	16	28.7		
59-82	5-0	12	21.2		
30m Vertical Height					
0-41	30-15	20	36.4	2.2	6.2
41-59	15-10	16	28.7		
59-82	10-5	12	21.2		
82-118	5-0	8	14.1		

Mine Earth (2017) assessed the erosional stability properties of conglomerate-oxide/NAF-oxide waste rock from site visit observations and laboratory testwork on grab samples. Key findings from Mine Earth (2017) are summarised below.

- An historic WRD was located adjacent to Novo's pilot mining project at Golden Crown. The WRD was approximately 20 years old and had approximately 20 m high angle of repose (+35°) slopes (Figure 3). The steep slopes of the historic WRD demonstrated reasonable erosional stability. Erosion gullies were observed on the historic WRD slopes due to uncontrolled drainage from the WRD top surface overtopping onto the WRD slopes.
- Conglomerate-oxide waste rock samples from the historic WRD had similar physical properties to the conglomerate-oxide waste rock samples from Novo's pilot mining area at Golden Crown (Figure 2). This was determined from both field observations and laboratory test work and indicates that the historic WRD may provide a useful reference for likely erosion rates from Project WRDs.
- Conglomerate-oxide waste rock has a propensity to remobilise when exposed to uncontrolled concentrated drainage. This was observed from the historic WRD and from the pilot mining area at Golden Crown. Effective drainage control is required to minimise the potential for erosion of the conglomerate waste rock.

Figure 2 Historic mining areas (May 2017)

Figure 3 Novo trial mining area (May 2017)

2.5.2 Surface soils

A key component of Pendragon (2015) involved undertaking flume testwork to determine the erodibility properties for surface soils from the Project area and applying these as inputs to the WEPP model to inform the design of stable waste rock dumps.

Pendragon (2015) collected 27 soil samples from across the Project area and assessed the erodibility of one large composite soil sample via inter-rill erodibility test (rainfall simulator) at 15° slope angle and rill erodibility test (erosion flume) at 15° slope angle. These tests provided the primary inputs for the WEPP slope erosion model to predict field-scale erosion rates for a range of potential linear slope configurations ranging from 12-18° with lift heights of 10-20 m. The models assumed no runoff from upstream catchments and no concentration of surface water flows.

Whilst the composite soil sample tested by Pendragon (2015) is not directly comparable to deeper NAF-oxide that will reside on the final surfaces of constructed landforms at the Project, the erosion results from the surface soils should provide an approximation of the worst-case scenario for erosion rates from final landforms. A comparison of the particle size distribution (PSD) data from the soil samples assessed by Pendragon (2015) and the waste rock (conglomerate/NAF-oxide) samples assessed by Mine Earth (2017), demonstrates that waste rock exhibits much coarser PSD results than surface soils. This supports the theory that erosion results from soil samples should provide an approximation of the worst-case scenario for deeper conglomerate-oxide.

Pendragon (2015) reported that WEPP modelling results showed that surface soils performed well in terms of both rill and inter-rill erosion resistance. The soil surface was self-armouring and resulted in a soil surface that was largely covered by a protective layer of gravels after simulated rainfall.

For lift heights of 10 m WEPP modelling predicted erosion rates of less than 5 t/ha/yr for all slope angles (12-18°). If lift heights were doubled, it was predicted that this would result in double the erosion rate i.e. <10 t/ha/yr for 20 m high lift with a 18° slope angle (Pendragon 2017).

2.6 Waste rock drainage properties

A cover system will be required to minimise the potential for acidification of PAF waste rock from the Project and to provide a growth medium for vegetation. Cover systems are used to provide a stable, reliable and sustainable engineered interface between the receiving environment and hostile waste rock (INAP 2017).

A range of cover system options are available, depending upon local climatic conditions and the range of available construction materials. For arid zone settings, dry covers are typically the most appropriate cover system (GARD 2011). Dry covers are designed to reduce net percolation (NP) reporting through the cover system. NP can be managed by diverting surface water away from the cover or by capturing surface water in a store and release system (Figure 4).

Store and release cover systems limit NP by storing surface water within the cover and then releasing it via evapotranspiration. The efficacy of a store and release cover system is contingent upon the infiltration and water retention properties of the available materials. Where suitable materials are not available, an alternative cover system such as a barrier-type system may be used. A barrier-type cover utilises a low hydraulic conductivity layer to control NP.

The performance of cover systems designed to manage NP is typically measured by the percentage of rainfall that reports as NP. For example, for a cover system with a predicted NP of 5% it would be expected to experience 5 mm of seepage beneath the cover system for every 100 mm of rainfall. For a hot desert arid zone setting the following performance categories apply (INAP 2017):

- Very low NP 1%
- Low NP 1-5%
- Moderate NP 5-10%
- High NP >10%

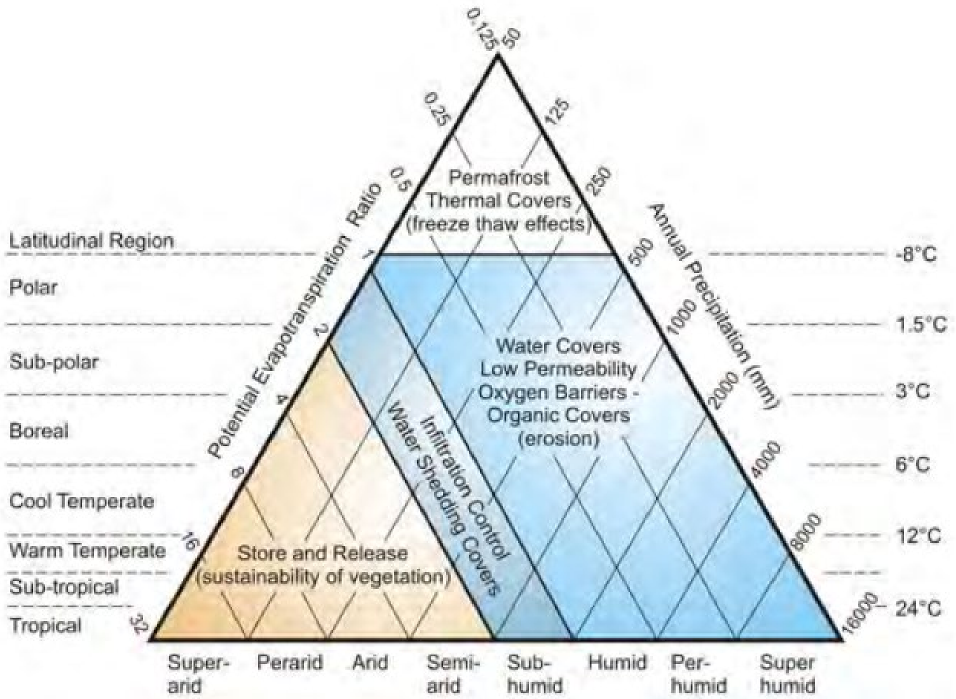

Figure 4 Cover systems and climate types (GARD 2011)

2.6.1 Hydraulic conductivity

Mine Earth (2020) assessed the hydraulic characteristics of potential cover materials from the Project to determine whether the waste rock generated during mining could be used to form a viable cover system on constructed landforms to minimise the potential for acidification of PAF waste rock via infiltration control. Mine Earth (2020) assessed the infiltration and water retention characteristics of conglomerate/NAF-oxide and Mosquito Creek Formation material via laboratory analyses and field measurements and undertook cover performance modelling to predict the effectiveness of a range of cover system configurations.

The particle size distribution of the conglomerate/NAF-oxide and Mosquito Creek Formation materials is dominated by the coarse rock fraction (approximately 70%). The <4.75 mm size fraction is dominated by sands, with the clay fraction measured as 16% of the <4.75 mm size fraction for the Mosquito Creek Formation and 17% for the conglomerate-oxide. Neither the conglomerate-oxide nor Mosquito Creek Formation material are prone to dispersion of the clay fraction (Mine Earth 2020)

The laboratory based saturated hydraulic conductivity (K_{sat}) results for the conglomerate-oxide ranged from 449 to 4.3 x 10^{-1} mm/hr depending upon the degree of compaction and presence of coarse rock fragments. The laboratory Ksat results for the Mosquito Creek Formation ranged from 9.6 to 1.5 x 10^{-2} mm/hr depending upon the degree of compaction. (Mine Earth 2020)

The field-based Ksat assessment (Guelph Permeameter) of the backfilled conglomerate-oxide within the Novo trial mining area had a much lower Ksat than the laboratory results (1.36 x 10^{-2} mm/hr to 9.26 x 10^{-2} mm/hr). It is thought that the field results may provide a more reliable indication of the likely Ksat of the conglomerate-oxide due to: the as-mined nature of the materials; the backfilled area had been subjected to multiple wetting / drying cycles; and consolidation and redistribution of illite clays which were identified as a major clay mineral of the conglomerate-oxide (Mine Earth 2020).

2.6.2 Waste rock hydraulic properties and vadose zone modelling

GCA (2020b) assessed the water retention characteristics of the as-mined conglomerate/NAF-oxide waste rock from the Project, as well as a sample of the Mosquito Creek formation material sourced from an adjacent mining operation. The water retention values for the conglomerate-oxide (<4.75 mm) are presented in Figure 5.

Okane (2021) established cover performance requirements for a store and release cover for the Project. Given the multiple lines of controls for PAF management being applied at the Project and the climate setting, Okane (2021) concluded that a moderate net percolation (NP) rate (5–10% of average annual rainfall) was an appropriate NP target for a store and release cover for Project landforms.

Mine Earth (2020) completed one-dimensional vadose zone modelling to assess the performance of several different cover systems for Project landforms. The conglomerate-oxide water retention curves from GCA (2020b) were used to derive the van Genuchten-Maulem parameters for use in the vadose zone modelling. Each scenario was run for a 20-year period using a representative climate record developed for the Project.

Three modelled cover systems achieved the target NP of ≤10%; (i) a 2 m cover of compacted conglomerate oxide, (ii) a 1.7 m layer of compacted conglomerate oxide overlaying a 0.3 m screened and compacted layer of Mosquito Creek Formation material, and (iii) a 2 m cover of conglomerate oxide overlying a low permeability synthetic liner (Mine Earth 2020). Only minor quantities of Mosquito Creek Formation material will be generated during mining and there is unlikely to be enough to use this material as part of a landform cover system.

Okane (2021) reviewed the various cover options available for the Project landforms and, given the site conditions, determined that a 2 m store and release cover system constructed from compacted conglomerate oxide was appropriate.

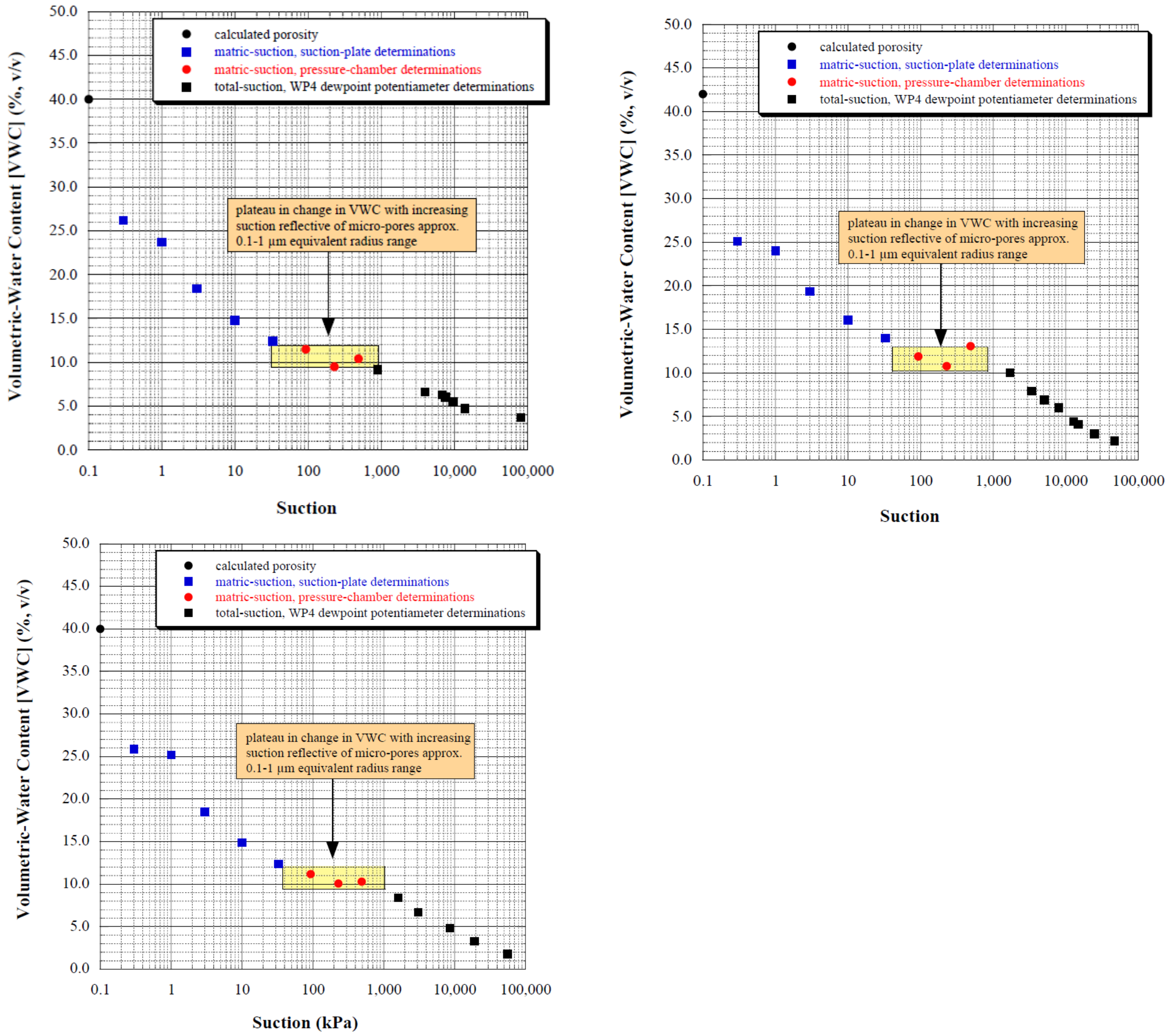

Figure 5 Water retention curves for the conglomerate-oxide (GCA 2020b)

2.7 Hydrogeology

Groundwater resources at the Project are located within three aquifers namely the Mosquito Creek Formation Aquifer (MCFA), the Hardy Formation Aquifer (HFA) and the alluvial aquifer system. The MCFA and HFA are fractured bedrock aquifers and are highly compartmentalised with little to no regional groundwater connection and flow (SRK 2021a). Drinking water is supplied to Nullagine from bores that exploit the MCFA and that are located approximately 8 km northeast of Nullagine (SRK 2021a).

SRK (2021a) reports that there is no hydrogeological connection between the Nullagine drinking water supply bores and the location of the proposed mining activities at the Project. This is supported by multiple lines of evidence collected over almost a decade of studies (360 Environmental 2021):

- The degree of compartmentalisation of the groundwater system in the Project area, supported by;
    - The style and distribution of water quality data in the area.
    - The $MgSO_4$ characteristics of groundwater are indicative of a stagnant groundwater system.
    - The general lack of recharge response in monitoring bores.
    - The response of monitoring bores to pumping data.
- The differences in water quality between the Project area (sulfate values 1,000 mg/L to 10,000 mg/L) and that reported for the drinking water supply bores (40 mg/L to 60 mg/L).
- The existing poor water quality (pre-dating mining by BCG) at the Project area has not impacted the safe operations of the town water supply over the ~40 years of its operation.
- Isotope data which shows the distinction between aquifers in the Project area and the Town Bores.

There are no sensitive groundwater dependent ecosystems located in the vicinity or downgradient from Beatons Creek. The area is located within the surface catchment of the drinking water supply bores for the settlement of Nullagine and lies within the Priority 1 (P1) Drinking Water Source Protection Reserves. Water supply bores NB6/92 and NB7/92 are the key receptors of concern. There are no other known receptors of concern which access the fractured rock groundwater system in the area (360 Environmental 2021).

2.8 Surface hydrology

The Project area is characterised by steep and narrow valleys and deeply incised creeks that drain towards the east to the Nullagine River. All surface water systems within the Project area are ephemeral and only flow during and after periods of significant rainfall (>10 mm/day) (SRK 2021b).

A dam is located on the eastern edge of M46/11, immediately east of the Project areas. The dam was constructed by Metana Minerals N.L in 1982 and used for their Alluvial Operations. The dam is not used as a source of drinking water however some residents of Nullagine use the dam as a seasonal swimming location (360 Environmental 2022).

2.8.1 Flood modelling

KCB (2018) undertook a hydrology study and hydraulic assessment of seven creeks within the Project area to estimate the 1 in 1,000 AEP and PMF flood extents. The flood maps developed by KCB (2018) were used to inform the placement of Project infrastructure and landforms, and to assess the flood risks associated with key Project infrastructure.

2.8.2 Grants Hill diversion

SRK (2021b) assessed the catchment to the west of the proposed Grants Hill pit and developed a conceptual surface water management plan for the pit. There are two surface water catchment areas that drain to the Grants Hill pit and these have a combined catchment area of 132 ha (Figure 6). Once the Grants Hill pit has been backfilled, the original drainage channels will be reinstated to convey surface water flows across the backfilled pit at closure.

SRK (2021b) developed a conceptual design for the reinstated channel over the pit backfill. The channel was designed to accommodate the 0.1% AEP peak flows with no additional freeboard. Summary design information for the channel is presented in Table 3. The longitudinal gradient of the channel is relatively flat at approximately 1%.

The potential impact of backfill settlement after construction on the long-term performance of the channel was raised by SRK (2021b). Measures to mitigate this risk will be investigated and implemented.

Additional smaller catchments are located around the Grants Hill pit and these drain towards the pit.

Table 3 Channel design summary

Rainfall event	0.1% AEP	50% AEP
Design peak flow	51 m^3/s	6.1 m^3/s
Base width	8 m	8 m
Maximum flow depth	1.2 m	0.4 m
Peak velocity	3.3 m/s	1.7 m/s
Rock armour size (d_{50})	100 mm	31 mm

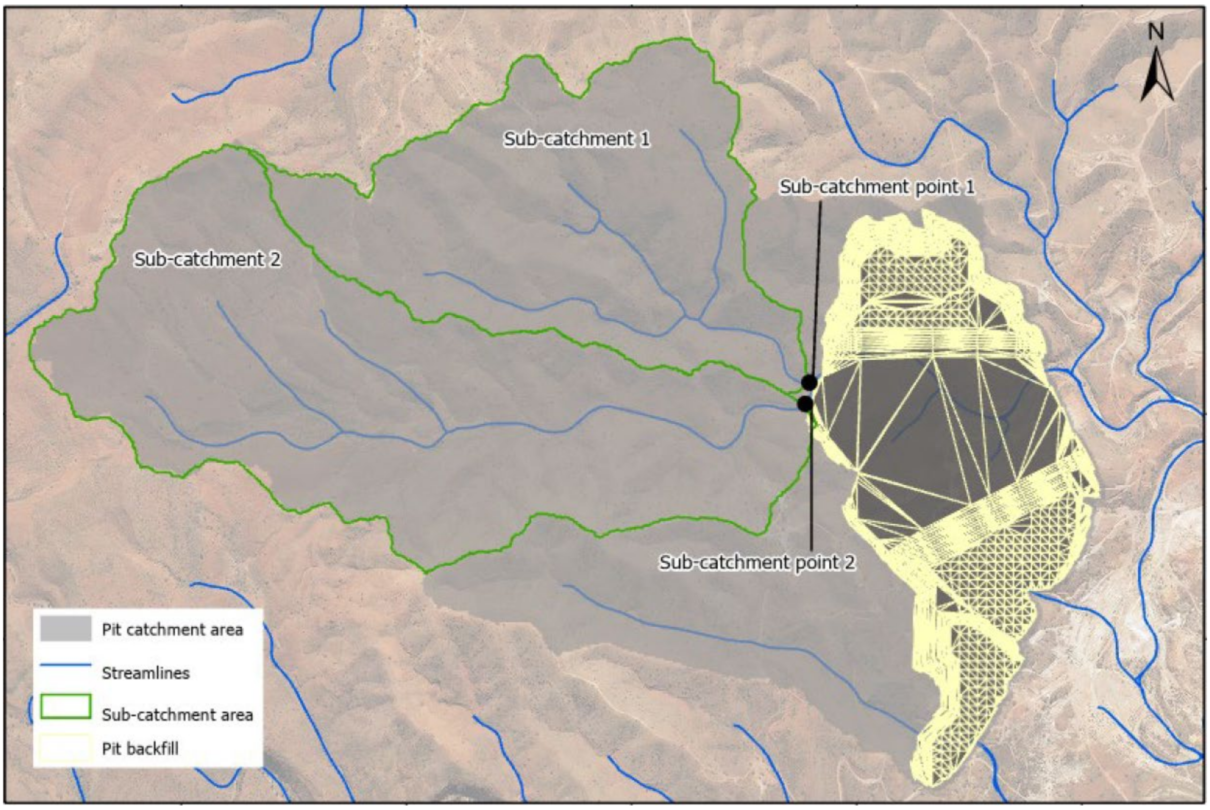

Figure 6 Grants Hill pit surface water catchments

2.9 Climatic conditions

The climate in Nullagine is hot and arid. Mean annual rainfall is 326 mm (BoM 2020a) and annual average evaporation is 3,321 mm (BoM 2020b). Rainfall predominantly occurs during the summer period between December and March and is predominantly influenced by tropical and monsoonal drivers (DPIRD 2020a). The monthly mean maximum temperature ranges from 26.8°C (July) to 41.6°C.

Current climate change predictions for the region are (CSIRO 2020):

- Average temperatures will continue to increase in all seasons.
- More hot days and warm spells.
- Changes to rainfall are possible but unclear.
- Increased intensity of extreme rainfall events.

Design extreme rainfall events have been determined for the Project (Table 4). The 1% to 0.05% AEP rainfall events were sourced from BoM (2022). The PMP events were sourced from KCB (2018).

Table 4 Design rainfall depth (mm)

Rainfall event	1% AEP	0.2% AEP	0.1% AEP	0.05% AEP	PMP
1 hour	70.3 mm	94.8 mm	106 mm	119 mm	426 mm
6 hour	142 mm	195 mm	220 mm	247 mm	1,035 mm
24 hour	239 mm	324 mm	364 mm	407 mm	1,147 mm
72 hour	279 mm	358 mm	394 mm	430 mm	2,080 mm

3 LANDFORM DESIGN REQUIREMENTS

The process to select the preferred landform closure design option is described in this section, along with the underlying design philosophy and specific design requirements.

3.1 Preferred landform closure design

Identification, development and evaluation of landform closure design options for the Project has been a collaborative process over several years between Novo and their consultants including Graeme Campbell and Associates, SRK, Okane Consultants, 360 Environmental, Auralia Mining Consultants and Mine Earth.

Risk assessment and multi-criteria analysis (MCA) were used for the identification and evaluation of options, and for the selection of the preferred conceptual landform closure design for the fresh rock Project. This section describes the MCA process and results in the following order:

- Identification of the key inherent risks relating to the post-mining landform.
- Identification of controls and subsequent options to manage key inherent risks.
- Evaluation of the merits of each option against a defined set of criteria.
- Selection of the preferred ‘go-forward’ option for the post-mining landform.
- Evaluation of residual risk after the implementation of the preferred option.

3.1.1 Risk assessment

The MCA commenced with a risk assessment to identify key inherent closure risks and causes (prior to risk controls) relating to waste rock and PAF management and the final post-mining landform. The key risks that were identified included (Table 5):

- Negative impacts to public health and safety.
- Poor pit lake water quality.
- Negative impacts to surface water quality.
- Uncontrolled drainage on constructed landforms.
- Impacts to natural drainage.
- Local flooding impacts on constructed landforms.
- Negative impacts to groundwater quality and the town water supply.

3.1.2 Options identification

From the risk assessment, controls were identified to manage inherent risks and these are presented in Table 6. The risk controls were collated into ‘options’ to be assessed through the MCA. The closure options are presented in Table 7.

Table 5 Assessment of inherent closure risks (risk matrices were sourced from ICMM 2019)

Event	Causes	Consequences	Inherent risk
Negative impacts to public health and safety.	Fall off pit high wall.	Human fatality.	Significant (18)
Poor pit lake water quality.	Human interaction with poor quality pit water. PAF exposure on pit walls.	Human injury or health impact. Impacts to ecological receptors, fauna death. Potential impacts to adjacent groundwater quality.	Significant (18)
Negative impacts to surface water quality.	Inadequate management of PAF waste rock. Unacceptable levels of erosion on landforms. Inadequate controls to manage drainage on and around landforms. PAF rock exposed on pit walls.	Impacts to receiving environment. Impacts to local flora and fauna. Impacts to recreational dam water quality.	Significant (17)
Uncontrolled drainage on constructed landforms.	Inadequate controls designed/constructed to manage drainage on landforms. Landform design configuration is not suited to material properties.	Unstable landforms. Exposure of PAF rock. Impacts to surface water quality. Poor rehabilitation performance.	Significant (17)
Impacts to natural drainage.	Upstream drainage cut off by Grants Hill pit.	Loss of downstream flows. Ecological impacts. Stability impacts to constructed landforms.	Significant (13)
Local flooding impacts on constructed landforms.	Landforms constructed in flood zone of local drainage channels. Inadequate controls designed/constructed to manage drainage on and around landforms.	Erosion. Geotechnical instability. Exposure of PAF and resulting AMD. Impacts to surface water quality.	Significant (13)
Negative impacts to groundwater quality and the town water supply.	AMD impacts from PAF waste rock as backfill in the Grants Hill pit or in the Central WRD. Poor pit water quality. PAF rock exposed on pit walls. Poor quality groundwater in/around the backfilled pit moves downstream.	Negative impacts to town water supply.	Medium (10)

Table 6 Risk controls

Inherent risks	Controls
Negative impacts to public health and safety.	• Backfill Grants Hill pit. • Construct drainage diversion over Grants Hill pit.
Poor pit lake water quality.	• Backfill Grants Hill pit. • No pit lake will form
Negative impacts to surface water quality.	• Maximise placement of PAF rock into pit backfill below the water table. • Ensure PAF rock has an adequate cover of NAF rock in final landforms. • Adopt a conservative closure design for landforms to minimise erosion.
Uncontrolled drainage on constructed landforms.	• Backfill Grants Hill pit and reinstate the natural drainage channel over the pit backfill. • Maximise backfill within the Grants Hill pit to close off the minor catchments to the north of the pit. • Design/construct adequate controls to manage drainage on landforms.
Impacts to natural drainage.	• Backfill Grants Hill pit and reinstate the natural drainage channel over the pit backfill. • Maximise backfill of the Grants Hill pit to close off the minor catchments to the north of the pit.
Local flooding impacts constructed landforms.	• Avoid constructing landforms in flood zones or across major drainage features (where possible). • Design/construct adequate controls to manage drainage on and around constructed landforms.
Negative impacts to groundwater quality.	• Backfill Grants Hill pit. • Maximise placement of PAF rock below the final water table in the pit. • Construct drainage diversion over Grants Hill pit.

Table 7 Collated options

Options		Description
1	No backfill.	• No backfill of waste rock into Grants Hill pit. • All waste rock stored in Central WRD. • A large pit lake will form. • PAF exposed on pit walls. • Upstream catchments terminate at the pit.
2	Partial backfill to establish the drainage diversion.	• Backfill of a select portion of the Grants Hill pit to re-mining level to establish the drainage diversion. • Two open pits either side of the backfill would remain. • Two pit lakes would form either side of the backfill. • Some PAF storage below the final pit water level. • Still a large Central WRD. • PAF exposed on pit walls. • Minor catchments to the north would terminate into the pit.
3	Partial backfill to below pit water level.	• Some backfill of waste rock into Grants Hill pit to immediately below the final water table level. • Maximise PAF storage below the final pit water level. • Still a large Central WRD. • Still a large open pit. • A shallow pit lake will form. • PAF exposed on pit walls. • Upstream catchments would terminate into the pit.

Options		Description
3a	Partial backfill to below pit water level, with a drainage diversion.	• Option 3a is a variation of option 3 and involves increasing the height of the backfill (in one segment of the Grants Hill pit) to establish the drainage diversion. • Minor catchments to the north would still terminate into the pit.
4	Partial backfill to above pit water level.	• Some backfill of waste rock into Grants Hill pit to immediately above the final water table level. • Maximise PAF storage below the final pit water level. • Still a large Central WRD. • Still a large open pit. • No pit lake will form. • PAF exposed on pit walls. • Upstream catchments would terminate into the pit.
4a	Partial backfill to above pit water level, with a drainage diversion.	• Option 4a is a variation of option 4 and involves increasing the height of the backfill (in one segment of the Grants Hill pit) to establish the drainage diversion. • Minor catchments to the north would still terminate into the pit.
5	Partial backfill to above fresh rock boundary.	• Some backfill of waste rock into Grants Hill pit above the fresh rock boundary. • Maximise PAF storage below the final pit water level. • Still a large Central WRD. • Still a large open pit. • No pit lake will form. • No PAF exposed on pit walls. • Upstream catchments would terminate into the pit.
5a	Partial backfill to above fresh rock boundary, with a drainage diversion.	• Option 5a is a variation of option 5 and involves increasing the height of the backfill (in one segment of the Grants Hill pit) to establish the drainage diversion. • Minor catchments to the north would still terminate into the pit.
6	Complete backfill to the pit crest.	• No PAF exposed on pit walls. • The large catchment to the west could be conveyed over the backfill. • Minor catchments to the north would still terminate into the pit. • Centrals WRD would be smaller. • Maximise PAF within the backfill, especially below the final pit water level. • Final backfill surface could be rehabilitated. • No pit void and no pit lake.
7	Maximise pit backfill to above the pit crest.	• No PAF exposed on pit walls. • The large catchment to the west could be conveyed over the backfill. • The minor catchments to the north would be closed off. • Centrals WRD would be much smaller. • Maximise PAF within the backfill, especially below the final pit water level. • Final backfill surface could be rehabilitated. • No pit void and no pit lake.

3.1.3 Evaluation criteria

The MCA evaluation criteria were developed from experience with similar evaluations (Table 8). Criteria 1 to 4 relate to the effectiveness of the options in managing key inherent risks (identified from the risk assessment), namely:

1. Public health and safety.
2. Ecological receptors.
3. Groundwater quality and receptors.
4. Surface water quality and receptors.

Table 8 MCA criteria and descriptions

Criteria		Description
1	Effectiveness in managing key risks	Effectiveness in reducing impacts to public health and safety
2		Effectiveness in reducing impacts to ecological receptors
3		Effectiveness in reducing impacts to groundwater quality/receptors
4		Effectiveness in reducing impacts to surface water quality/receptors
5	Ease to construct	Ease with which the option could be implemented
6	Proven method	The effectiveness of the option has been proven in other cases
7	Capex	Cost to implement the option
8	Opex	Cost for ongoing maintenance and management of the option
9	Acceptance	Option likely to be acceptable to external stakeholders
10	Reputation	The option will have a positive impact on company reputation
11	Endurability	Long-term, post-closure effectiveness of the option; walk away solution

3.1.4 Options evaluation

The performance of each option was evaluated by allocating a score to each criterion. The weighted average score for each option was calculated and used to assess the relative performance of each option.

The MCA results are presented in Table 9.

Option 7 (Maximise pit backfill to above the pit crest) was the highest scoring option for waste rock and PAF management and was selected as the preferred go-forward option. Option 7 was the costliest option in terms of capital expenditure, but was determined to be the most effective option in managing the key, long-term closure risks relating to waste rock and PAF management and the final post-mining landform.

The weightings of all criteria were adjusted to assess the sensitivity of the preferred option to each criterion. Option 7 remained the highest scoring option under all weighting scenarios.

Table 9 Options evaluation weighted average score.

Options		Weighted average score
1	No backfill.	2.1
2	Partial backfill to establish the drainage diversion.	2.6
3	Partial backfill to below pit water level.	2.1
3a	Partial backfill to below pit water level, with a drainage diversion.	2.6
4	Partial backfill to above pit water level.	2.7
4a	Partial backfill to above pit water level, with a drainage diversion.	3.3
5	Partial backfill to above fresh rock boundary.	2.7
5a	Partial backfill to above fresh rock boundary, with a drainage diversion.	3.3
6	Complete backfill to the pit crest.	3.9
7	Maximise pit backfill to above the pit crest.	4.1

3.1.5 Residual risk

The ranking of the key closure risks from Table 5 were re-evaluated to determine the residual risk for each risk event after the implementation of the preferred option (Option 7). The inherent and residual ranking for key closure risks is presented in Table 10.

Table 10 Inherent and residual ranking of key closure risks

Event	Inherent risk	Residual risk
Negative impacts to public health and safety.	Significant (18)	Medium (6)
Poor pit lake water quality.	Significant (18)	Low (3)
Negative impacts to surface water quality.	Significant (17)	Medium (9)
Uncontrolled drainage on constructed landforms.	Significant (17)	Medium (9)
Impacts to natural drainage.	Significant (13)	Medium (9)
Local flooding impacts constructed on landforms.	Significant (13)	Medium (9)
Negative impacts to groundwater quality and the town water supply.	Medium (10)	Medium (10)

3.2 Design philosophy

The overarching philosophy for the preferred landform closure design is to establish safe, stable and non-polluting landforms capable of supporting self-sustaining native vegetation. The preferred design option was selected as it best managed the inherent closure risks relating to (Section 3.1):

- Residual mining voids with poor-quality pit water resulting in impacts to public health and safety, and to groundwater and ecological receptors.
- AMD from PAF rock stored in landforms and exposed on pit walls resulting in poor pit water quality and impacts to groundwater and surface water quality and ecological receptors.
- Natural drainage and cutting off the surface water catchment to the west of the Grants Hill pit.
- Excessive erosion, uncontrolled drainage and flooding impacts on landforms.

As described in Section 3.1 the preferred landform closure design option for the Project is to maximise the placement of waste rock as backfill into Grants Hill pit and place any surplus waste rock in the above ground Central waste dump (Figure 7).

The preferred landform closure design includes multiple controls for PAF management:

1. Maximise PAF placement as backfill in the Grants Hill pit, below the final water table.
2. Final store and release cover to minimise NP.
3. Tight backfill construction to minimise preferential flow paths.

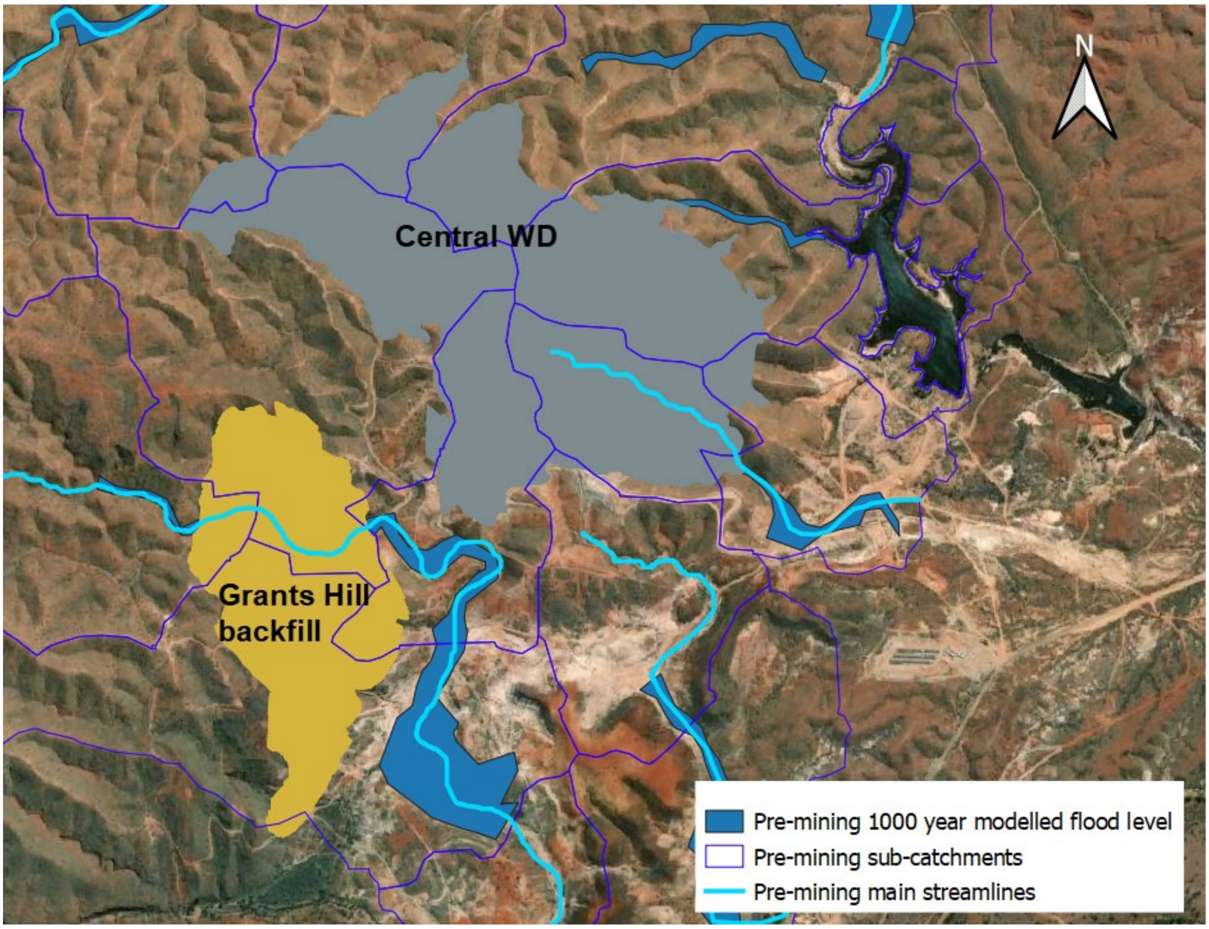

Figure 7 Beatons Creek waste landform locations and pre-mining drainage

There is insufficient capacity contain all PAF waste rock within the Grants Hill pit and it will be necessary to store some PAF waste rock within the Central WRD.

PAF waste rock shall not be placed above the water table beneath the drainage diversion in the Grants Hill pit, or within the water table zone that may be subjected to periodic wetting and drying associated with water table fluctuations. The backfill shall be constructed in layers to minimise the potential for differential consolidation (which may impact upon drainage performance), restrict the potential formation of preferential pathways and limit seepage through the PAF waste rock.

A store and release cover shall be established over both the Grant Hill backfill and Central WRD to restrict NP through to the underlying PAF waste (Section 2.6).

The waste landforms shall be designed to be internally draining. Flat surface areas will be formed to drain internally and store water away from the crest of downstream slopes to reduce the risk of overtopping and tunnel erosion.

The Central WRD shall be positioned such that it is outside of the flood-level of major drainage structures (Section 2.8.1) and so that it is high in the local catchment to avoid impacts with runoff from upstream areas. A diversion shall be constructed over the Grant Hill backfill to convey runoff from upstream catchments (Section 2.8.2) (Figure 7).

3.3 Design requirements

The landform design requirements for both PAF management and surface water management are described in this section.

3.3.1 PAF management

The multiple controls for PAF management are described in this section for the Grants Hill backfill and Central WRD, under the headings: store and release cover, lift construction and backfill construction.

3.3.1.1 Store and release cover

A 2 m thick (minimum) store and release cover will be constructed over all PAF rock (Figure 8). The aim of the cover is to minimize infiltration of rainfall (NP) to the buried PAF rock.

The store and release cover will consist of a 1.5 m thick (minimum) AO layer over PAF rock and a 0.5 m thick (minimum) NAF Oxide layer over the AO. Topsoil / growth media will be applied to the final surface where available. Compaction of the store and release cover layer will be optimised to maximise its water holding capacity and minimize NP, but an increase in depth of the store and release cover is unlikely to improve NP rates (Okane 2021).

The hydraulic characteristics of candidate cover materials were assessed from laboratory and field measurements and the efficacy of the store and release cover was assessed using vadose zone modelling (Mine Earth 2020). The proposed store and release cover is likely to achieve an acceptable NP performance target of 5-10% annual rainfall (Okane 2021).

Opportunities to optimise the design of the store and release cover will be explored once as-mined material is available.

Figure 8 Store and release cover; minimum 2 m thick (Okane 2021).

3.3.1.2 Lift construction

The backfill and waste dump will be constructed via low 10 m high lifts (Figure 9). The final 10 m profile, immediately below the final store and release cover, will be constructed in 5 m lifts. The aim is to achieve tight lift construction to:

- Minimise the development of preferential flow paths to minimize seepage and PAF oxidation.
- Minimise the potential for long term consolidation which may impact cover performance and drainage controls.

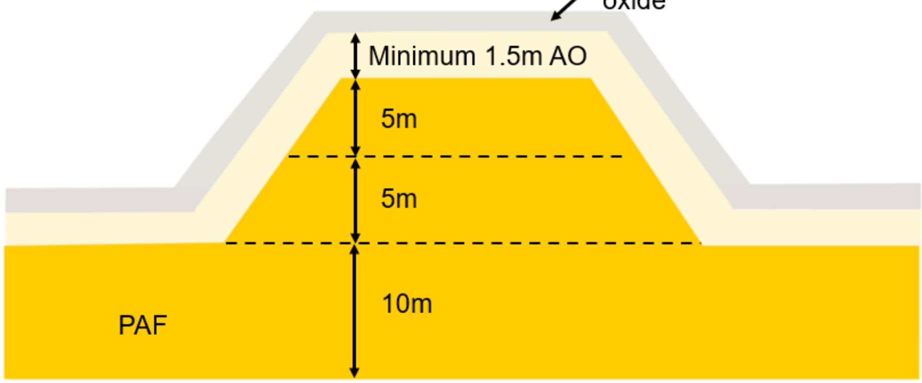

Figure 9 Tight lift construction; maximum 10 m lifts.

3.3.1.3 Backfill construction

PAF will not be placed at the final predicted water table level including a 10 m buffer, 5 m above and 5 m below the predicated final water table (Figure 10). The aim is to restrict wetting and flushing of PAF rock. AO will be placed at the water table zone.

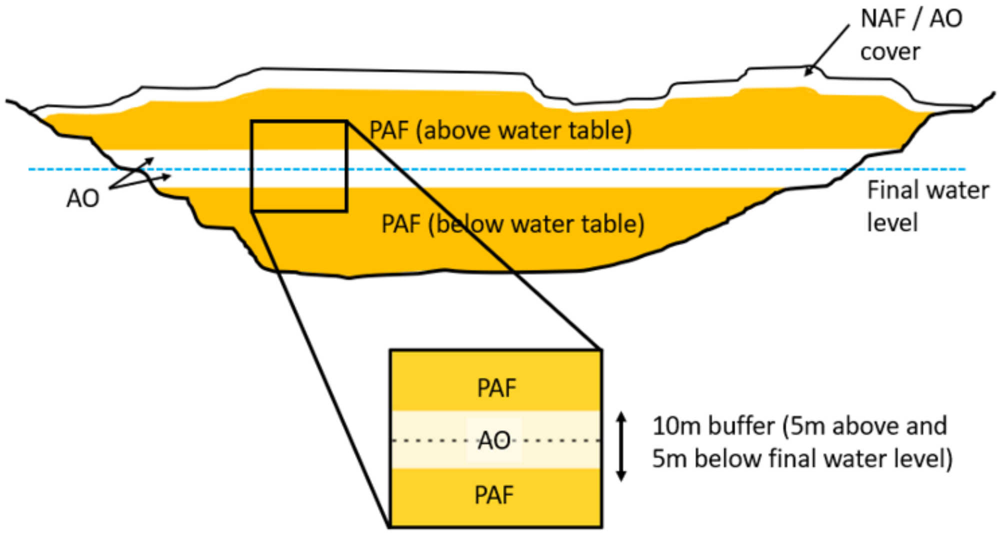

Figure 10 Grants Hill pit backfill – AO buffer at water table.

PAF will not be placed below the diversion drain over the Grants Hill backfill surface (Figure 11). The aim is to restrict wetting and flushing of PAF rock. AO will be placed below the diversion drain.

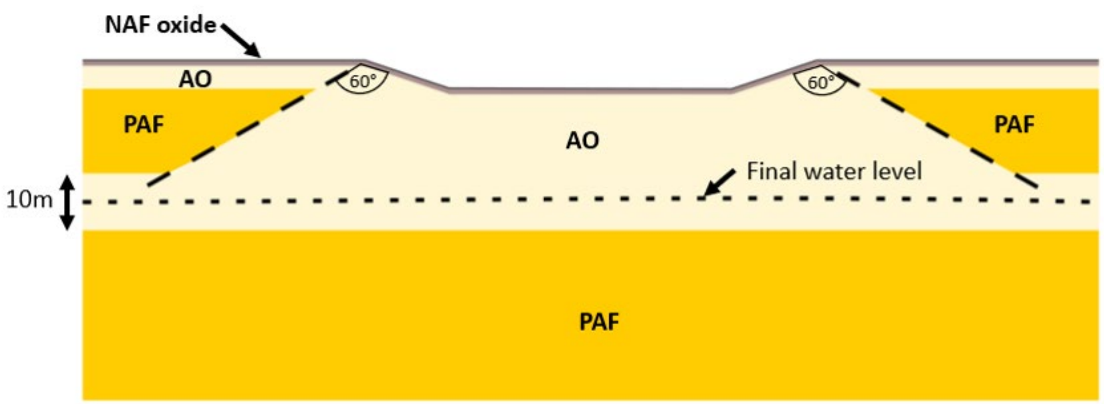

Figure 11 Grants Hill pit backfill – no PAF below the diversion drain.

3.3.2 Surface water management

3.3.2.1 Berm capacity sizing

The design requirement for landform berms is retention of the critical 0.1% AEP rainfall event with a minimum 300 mm freeboard in its as-constructed state.

Drainage modelling was undertaken to assess the capacity of landform berms to retain incidental rainfall and surface water runoff. The design berm configuration utilises a 20 m wide berm backsloping at 5° with a 10 m upstream lift with a slope angle of 18°.

Drainage modelling was undertaken using the DRAINS model and by applying the 24-hour and 72-hour 0.1% AEP rainfall events (Table 4). The hyetograph for each design rainfall event was developed using DRAINS.

Portions of the Central WRD are located between ridgelines which will also generate runoff to the berm surfaces. A model berm was selected which had the greatest ratio of catchment to storage area. The model berm therefore represents the most conservative scenario.

The catchment area of the model berm was calculated as 1.05 ha. The berm length that was modelled was 130 m. The saturated hydraulic conductivity was modelled as 2.5×10^{-6} m/s. Runoff from the upstream catchments was modelled using the ILSAX hydrological model, assuming a high runoff upstream catchment.

The drainage modelling predicted that the modelled berm could retain the critical duration 1,000-year rainfall event with a minimum 0.37 m freeboard in its as-constructed state. The modelled berm represented the most conservative scenario as it had the greatest ratio of catchment to storage area; all other WRD berm areas should therefore exceed the storage capacity of the modelled berm. The freeboard level for a given event will be greater where the proportion of runoff from natural ground to the berm storage volume is less. All other WRD berm areas should therefore exceed the storage capacity of the modelled berm.

3.3.2.2 Top surface backslope sizing

The design requirement for the top surfaces of landforms is retention of the critical 0.1% AEP rainfall event with a minimum 300 mm freeboard in its as-constructed state. Landform top surfaces should also prevent water ponding within 20 m of the landform crest.

The 72 hour 0.1% AEP for the Project is 0.39 m. Assuming the backslope is formed by cut-to-fill reprofiling, then a design depth of 1.4 m is required to achieve the design criteria. For a 20 m wide section of backslope, a backslope angle of ≥4° is therefore required to meet the design requirements.

4 LANDFORM DESIGN PARAMETERS

The landform design parameters have been developed in response to the design inputs presented in Section 2 and the design requirements presented in Section 3.

The agreed design parameters for Project landforms are presented in Table 11.

Table 11 Landform design parameters

Parameter	Value	Source/rationale
Maximum lift height	10 m	Mine Earth (2018)
Maximum batter slope angle	18°	Mine Earth (2018)
Minimum final berm width	20 m	Mine Earth (2018)
Minimum berm backslope angle	5°	Mine Earth (2018)
Minimum top surface backslope width	20 m	Limit potential for ponding near the crest
Minimum top surface backslope angle	4°	Sufficient storage depth to contain the 0.1% AEP rainfall event with 300 mm freeboard
Minimum combined alunitic oxide and NAF-oxide cover thickness	2 m	Okane (2021)
Minimum NAF-oxide cover at surface	0.5 m	Okane (2021)
Maximum lift height	10 m	The final 10 m profile below the store and release cover will be constructed in 5 m lifts
Mined material swell factor	1.3	Auralia Mining Consulting (2021)
Combined backfill and WRD capacity	31.4 Mbcm	Auralia Mining Consulting (2021)
Backfill diversion drain gradient	1–2%	SRK (2021)
Diversion drain minimum base channel width	8 m	SRK (2021)
Diversion drain maximum side slope	1V:4H	SRK (2021)
Diversion drain minimum depth	1.2 m	SRK (2021)
Diversion drain channel rock armour size (d_{50})	100 mm	SRK (2021)
PAF buffer at pit backfill final water level	10 m	Alunitic-oxide placed 5 m above and below final water level within pit backfill
PAF buffer below the diversion drain over pit backfill	60˚	Alunitic-oxide placed below the diversion drain, above the water table, at 60˚ from drain crest

5 CONCEPTUAL LANDFORM CLOSURE DESIGN

A three-dimensional conceptual landform closure design has been generated for the Grants Hill pit backfill and Central WRD. This design meets the agreed design parameters for Project landforms presented in Table 11 (Section 4).

The current landforms constructed during oxide mining at the Project were also designed in accordance with the relevant design parameters presented in Table 11. The current landforms will progressively evolve into the conceptual landform closure design presented in this section.

5.1 Grants Hill Backfill

The landform design and material requirements for the Grants Hill backfill are presented below.

5.1.1 Conceptual design

The conceptual landform closure design for Grants Hill pit backfill is presented in Figure 12 to Figure 15.

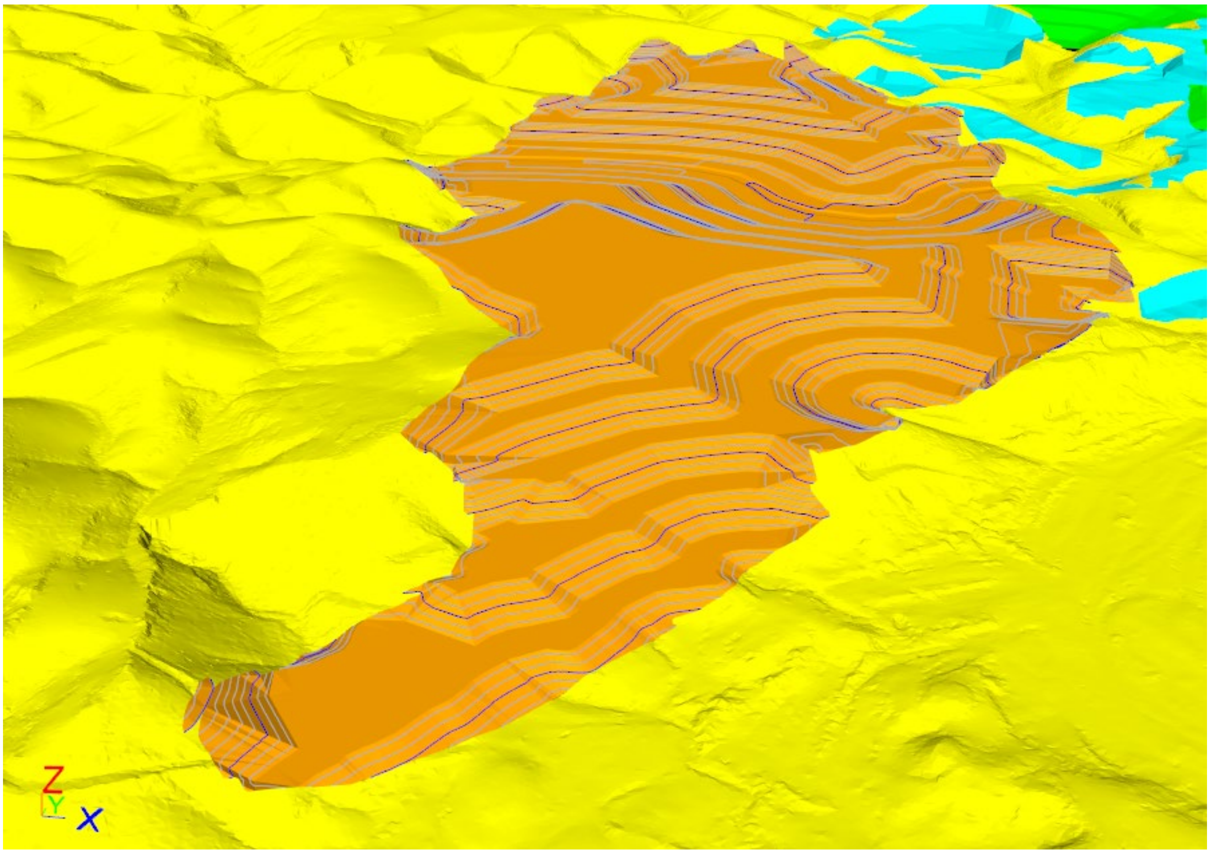

Figure 12 Grants Hill pit backfill (facing north, 2 m contours)

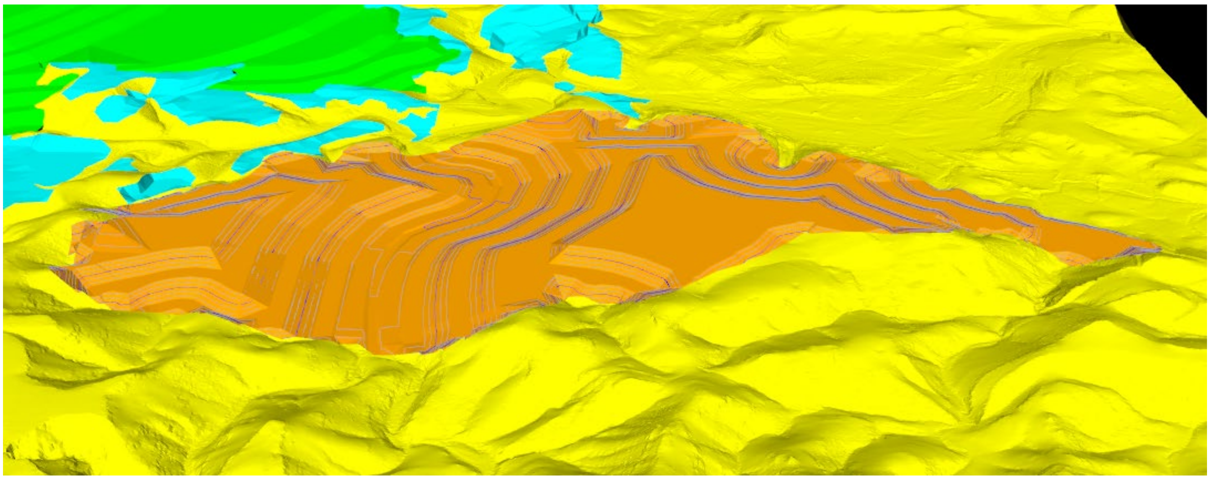

Figure 13 Grants Hill pit backfill (facing east, 2 m contours)

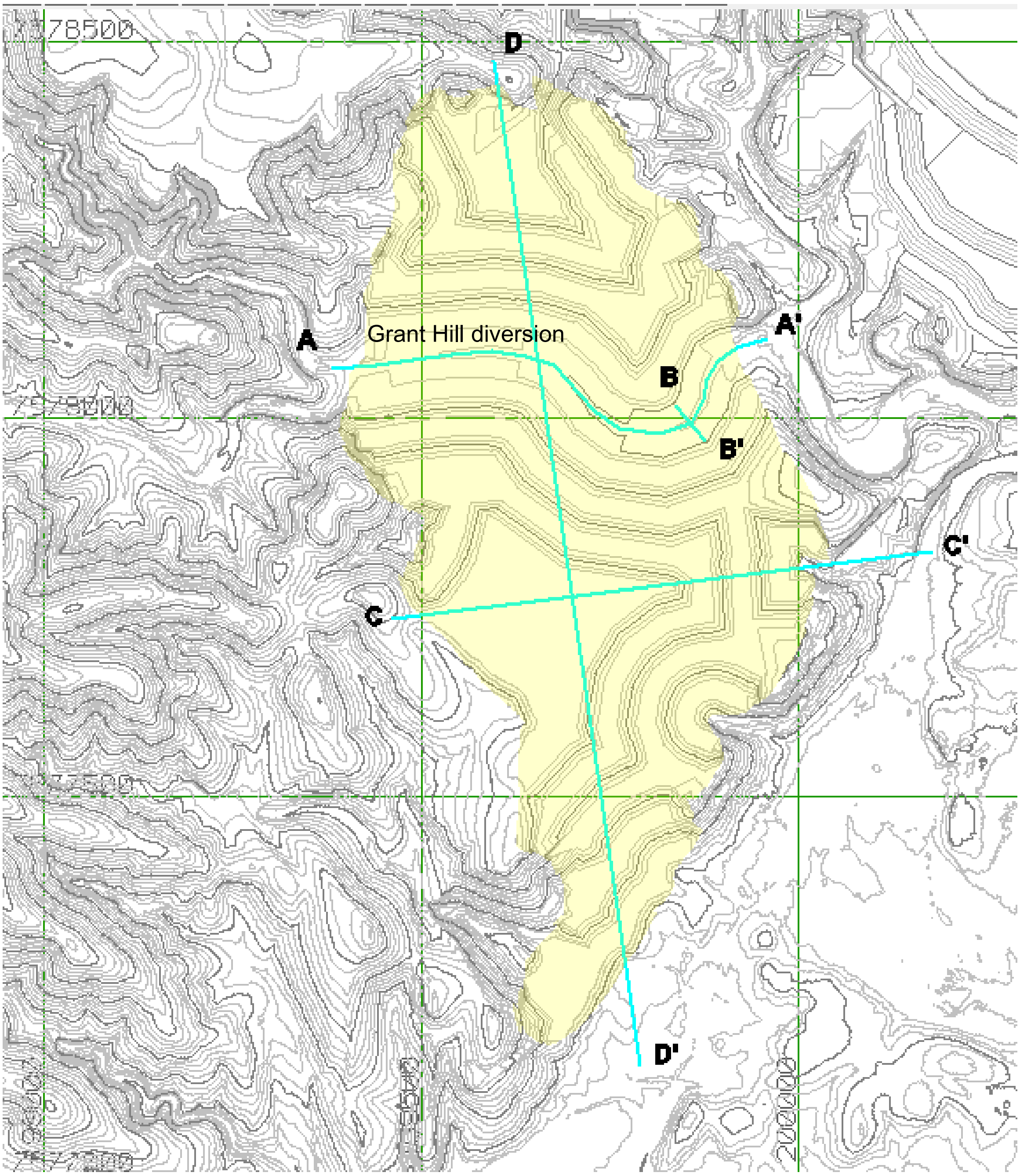

Figure 14 Grants Hill pit backfill plan (2 m contours)

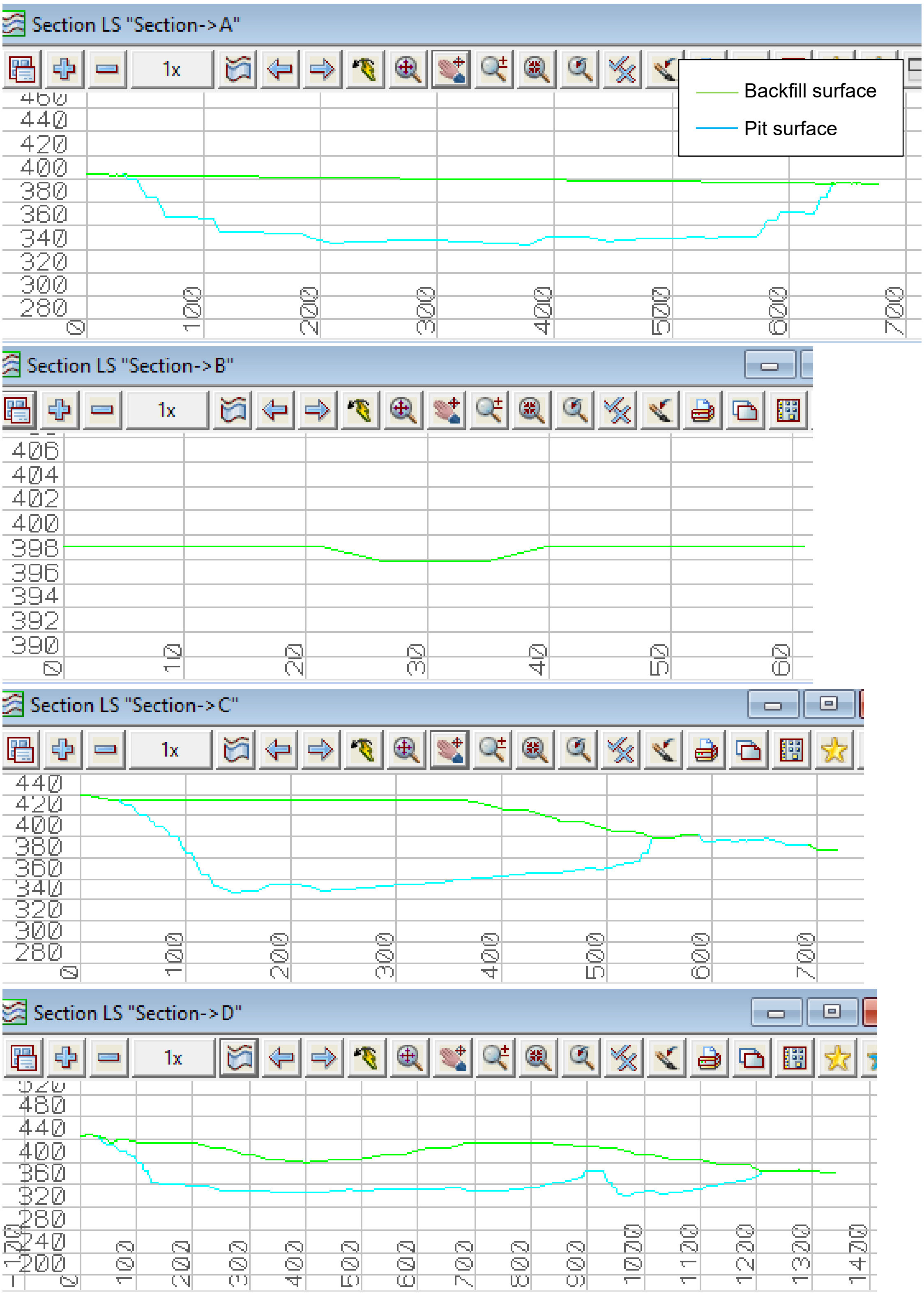

Figure 15 Grants Hill pit backfill sections

5.1.2 Material requirements

The Grants Hill pit backfill has a design capacity of 21.8 Mlcm. Indicative material requirements are presented in Table 12. The maximum available PAF storage capacity in Grants Hill pit is 14.9 Mlcm. It is likely that the total achievable PAF storage will be less than this in response to constructability and scheduling limitations. Wherever possible, Grants Hill pit backfill is the preferred location for storing PAF waste rock.

Table 12 Indicative Grants Hill pit backfill material requirements

Waste type	Volume (Mlcm)
NAF oxide	0.24 Mlcm
Alunitic oxide	6.62 Mlcm
Maximum PAF capacity	14.93 Mlcm

5.2 Central WRD

The landform design and material requirements for the Central WRD are presented below.

5.2.1 Conceptual design

The conceptual landform closure design for the Central WRD is presented in Figure 16 to Figure 19.

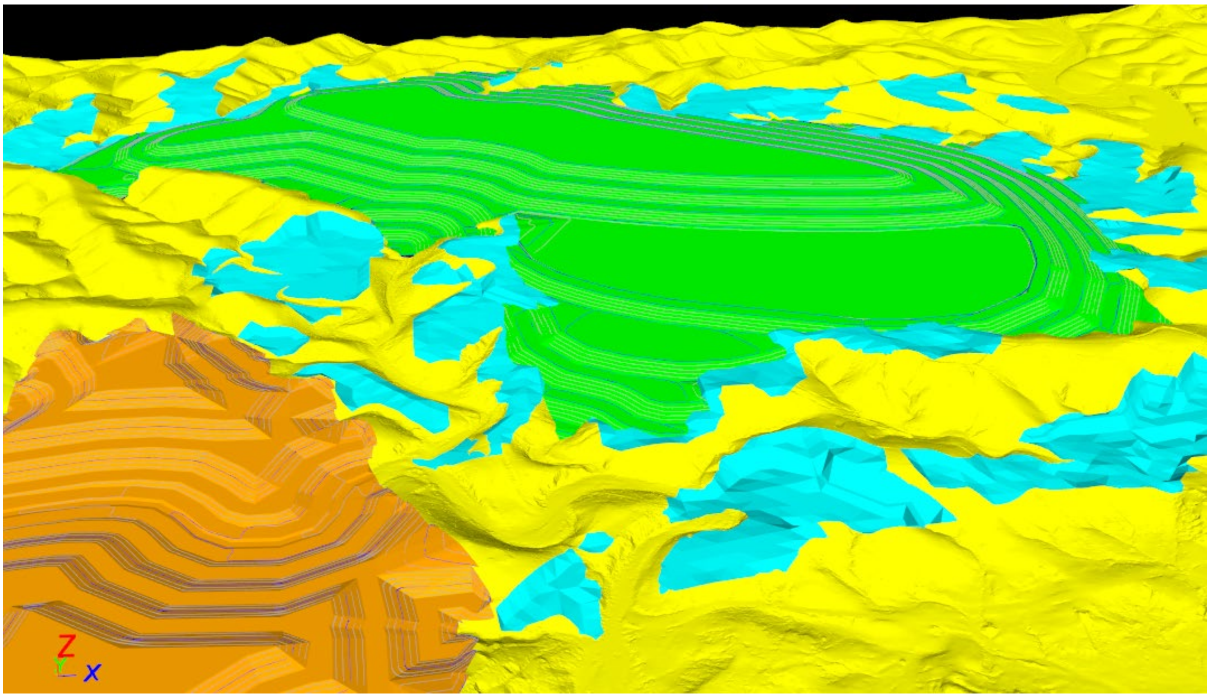

Figure 16 Central WRD closure design (facing north, 2 m contours)

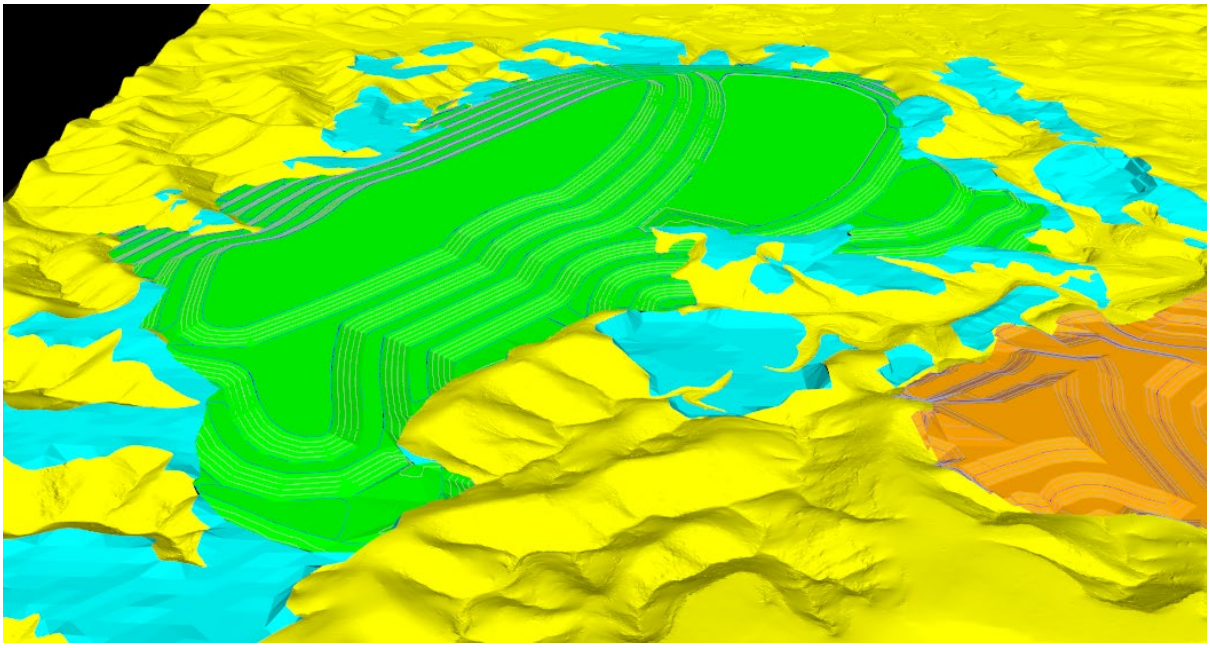

Figure 17 Central WRD closure design (facing east, 2 m contours)

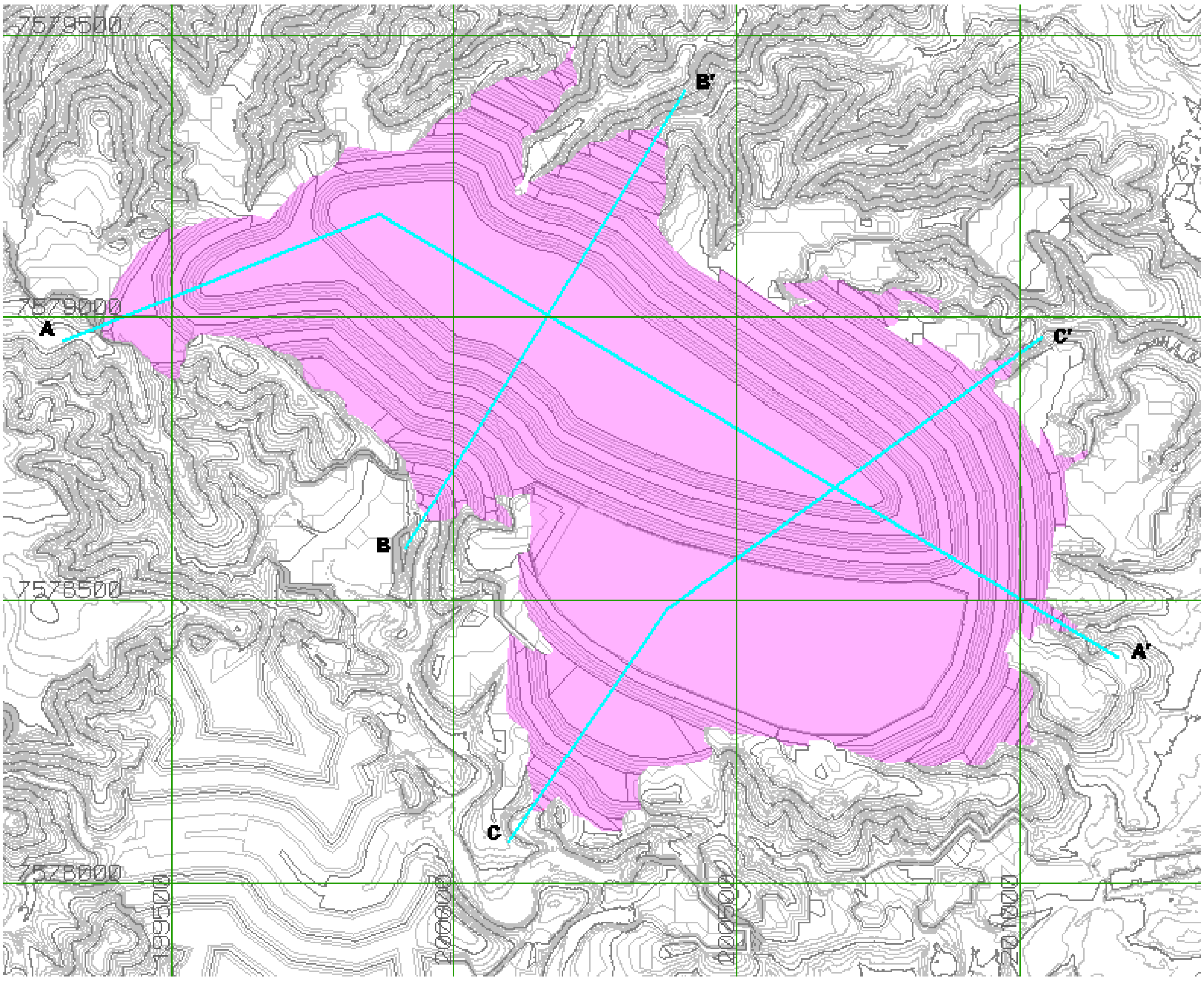

Figure 18 Central WRD plan view (2 m contours)

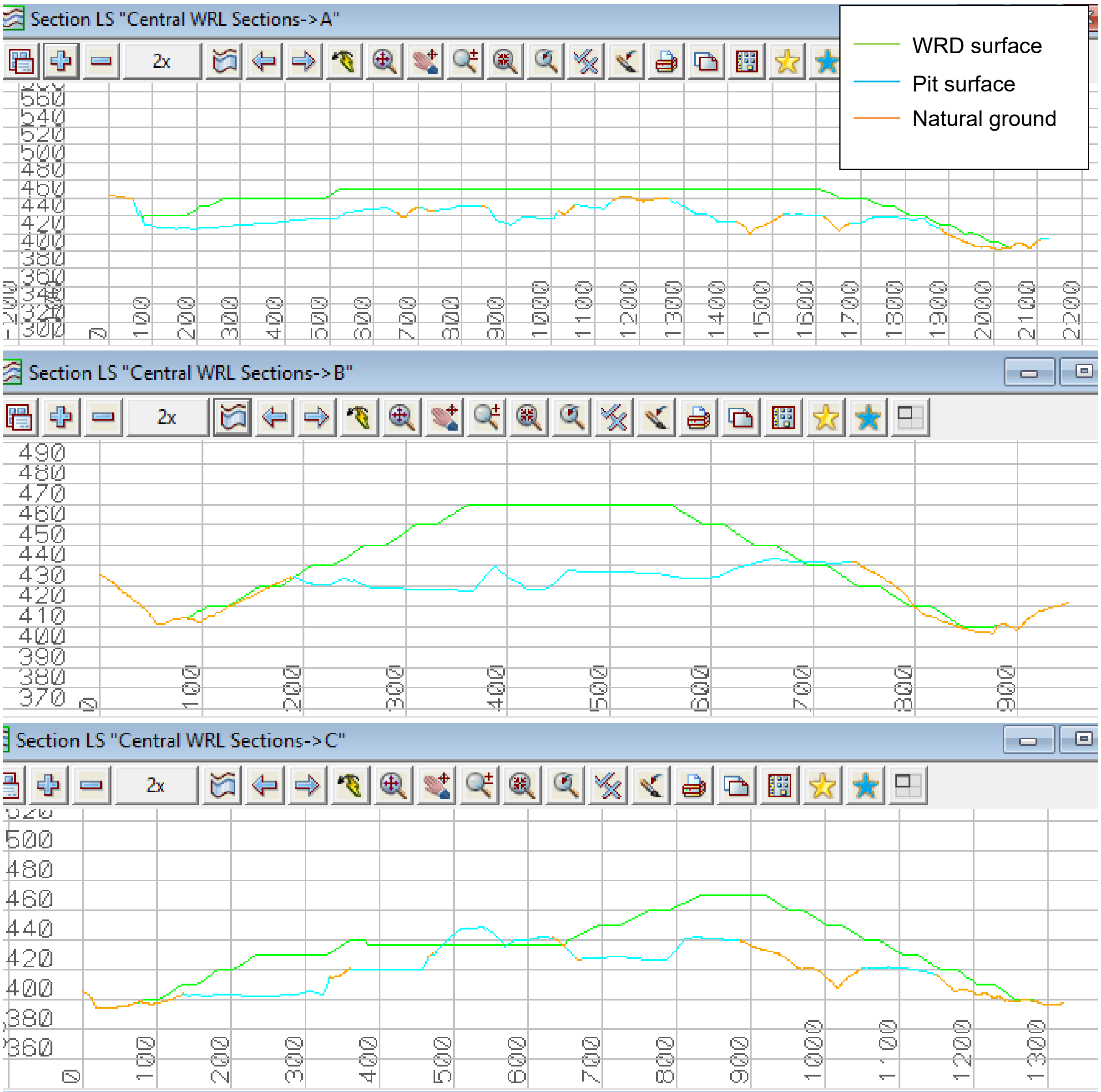

Figure 19 Central WRD closure design sections (x2 vertical exaggeration)

5.2.2 Material requirements

The Central WRD can contain 18.34 Mlcm. Most PAF waste rock will be stored within the Grant Hill pit backfill however some PAF waste rock will be contained within the Central WRD. A minimum 0.5 m layer of NAF oxide shall be required over the outer surface of the Central WRD. This shall require 0.57 Mlcm of NAF oxide.

5.3 Combined surface

The combined Grants Hill pit backfill and Central WRD surface is presented in Figure 20 to Figure 22.

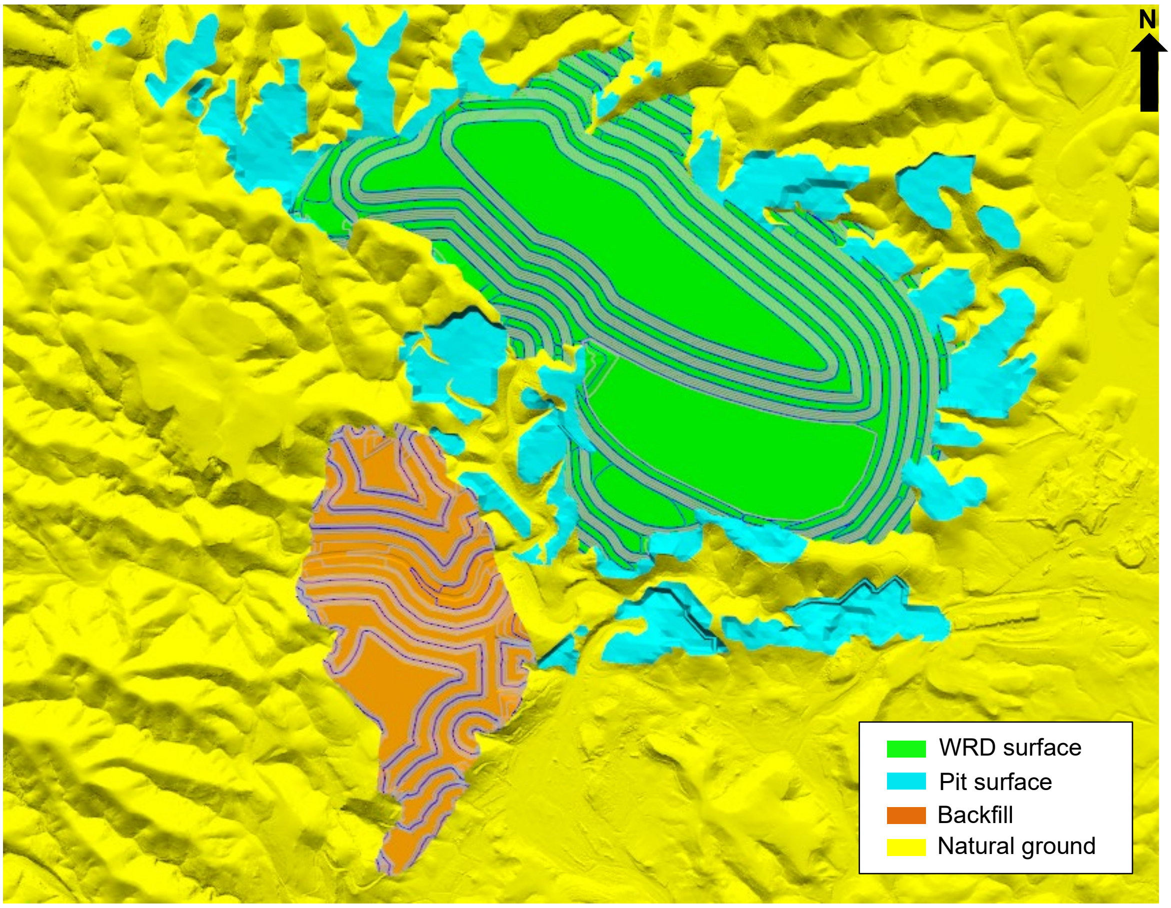

Figure 20 Combined landform surface (overhead)

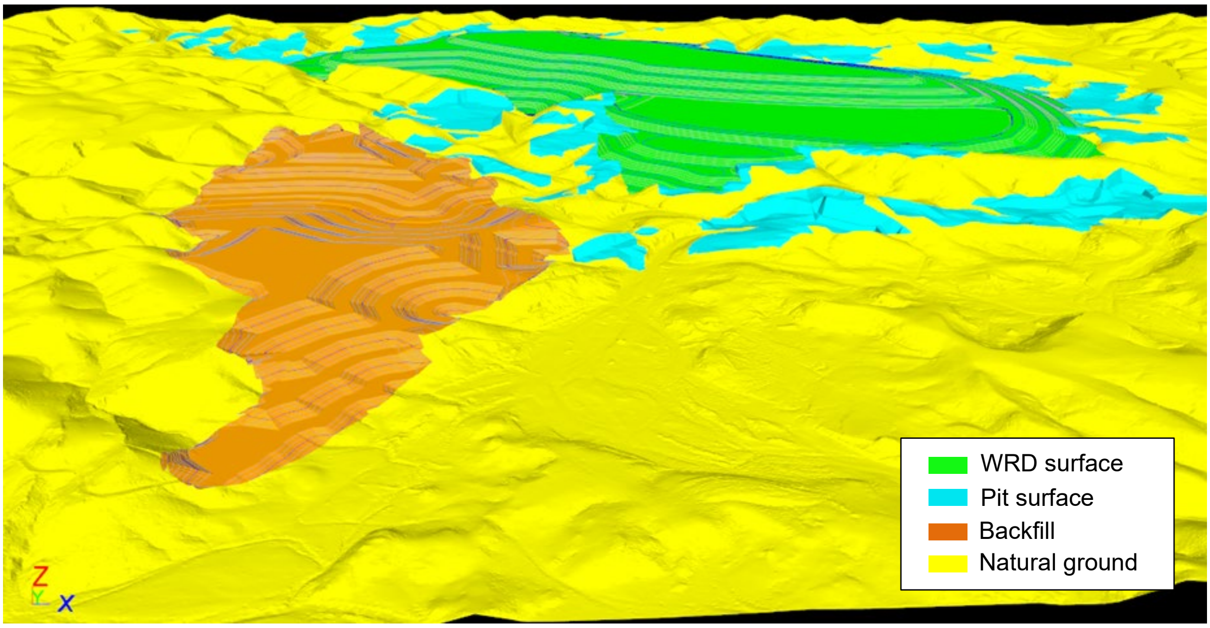

Figure 21 Combined landform surface facing north

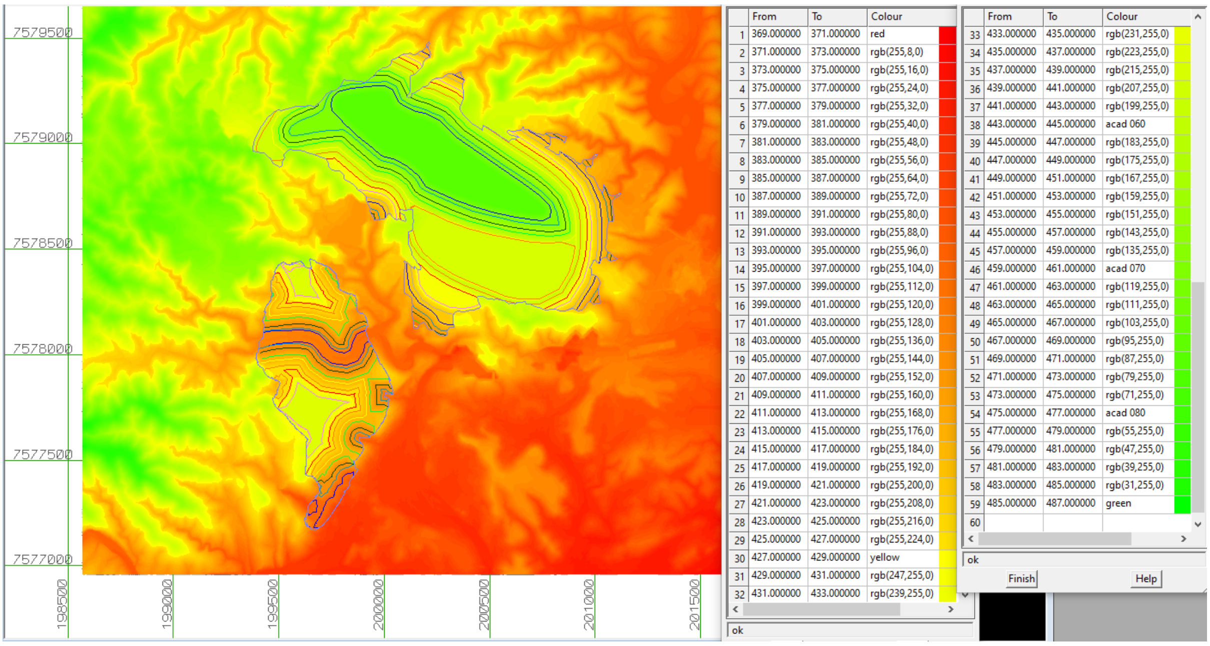

Figure 22 Combined landform surface elevation heat map

5.4 Materials balance

There is a forecast demand of 0.81 Mlcm of NAF oxide. There is a forecast production of 8.6 Mlcm of NAF oxide scheduled for the Project. Although there are competing demands for NAF oxide, it is anticipated that there shall be sufficient NAF-oxide available for construction of the conceptual landform closure design.

6 SOIL INVENTORY

6.1 Baseline soil assessment

A baseline soil and sediment characterisation program for the Project was undertaken by Pendragon in 2015 (Pendragon, 2015). Twenty-seven soil samples were collected from the slopes and hill tops across the Project area. Key physical and chemical characteristics of the sampled soils are summarised as follows:

- Soils are predominantly coarse to very coarse-grained, quartz rich sand and gravels. Most soils recorded sand and gravel contents greater than 80% and very low fines (clay) content.
- Average soil pH of 4.6 (classified as strongly acidic).
- Low electrical conductivity (EC) values ranging from 2–11 µS/cm (classified as non-saline).
- Low cation exchange capacity (CEC) ranging from 1.2–4 meq/100g. All soils are non-sodic.
- Generally low concentrations of total metals.
- Low concentrations of plant-available nutrients and total organic carbon.
- Low to moderate hydraulic conductivities.
- Non-plastic, with a low shrinkage potential.

In summary, the soils from the slopes and hill tops are considered suitable as a surface rehabilitation resource. The topsoil materials are low in plant-available nutrients and classified as strongly acidic, however local vegetation species are adapted to these characteristics. Physically, the soils have a high gravel / rock fraction and a relatively low erodibility (Section 2.5.2). The soils on slopes and hill tops were relatively homogenous across the Project area and can therefore be managed as a single unit.

The soils and sediments from within the drainage lines in the Project area comprise patchy areas of coarse alluvial sands and finer grained, clay rich materials in depositional zones. These soils are likely to be less suitable as a surface rehabilitation material than the surface soils from the slopes and hill tops. Due to their position in the landscape (i.e. drainage lines are typically narrow and incised) soil salvage from drainage lines and lower slopes is likely to be impracticable.

6.2 Existing stockpiled topsoil

A total of 87,235 m^3 of topsoil has been stockpiled to date from Project disturbance areas, salvaged from 47.75 ha of clearing (Novo pers. comm. 2022). This equates to an average topsoil salvage rate of approximately 0.18 m^3/m^2 from the cleared areas.

6.3 Estimate of available topsoil

An estimate of potential topsoil recovery for the Project has been developed, based on the following assumptions:

- Only topsoils from the upper slopes and hill tops will be salvaged. Inaccessible soils on the lower slopes, the alluvial soils and sediments within the drainage lines, and soil from existing disturbance areas is unlikely to be salvaged as part of pre-mining activities.
- The estimate is based on the maximum recoverable volume of topsoil across the entire Project area.
- Salvaged topsoil from the slopes and hill tops can be managed as a single unit.
- Topsoil materials can be recovered to a depth of 0.2 m across the undisturbed areas of the upper slopes and hill tops. The depth of soil across the slopes and hill tops is likely to vary considerably, with areas of shallow and outcropping rock present.
- An average topsoil recovery rate of 0.15 m^3/m^2 for the remaining undisturbed area.

The volume of topsoil potentially available, comprising existing stockpiled soil and potential soil resources from uncleared areas is detailed in Table 13.

Table 13 Estimate of available topsoil

Soil salvage factors	Value
Undisturbed area (ha)	92
Soil salvage rate (m^3/m^2)	0.15
Undisturbed topsoil volume (m^3)	165,600
Stockpiled topsoil volume (m^3)	87,235
Estimated total topsoil available (m^3)	**252,835**

6.4 Estimate of topsoil required for rehabilitation

The surface area of the proposed Grants Hill pit backfill and the Central WRD combined is approximately 161.5 ha. Assuming a topsoil application depth of 0.2 m, this would require approximately 323,000 m^3 of topsoil. Given the likely deficit of topsoil resources, application of a thinner topsoil layer during rehabilitation and/or prioritisation of topsoil resources to the highest priority rehabilitation areas is likely to be required.

7 FORWARD WORK PLAN

The high-level forward work plan to progressively advance the conceptual landform closure during mining includes:

- Assess and verify as-mined waste rock properties during mining and optimise cover system and landform closure designs.
- Develop tip-to designs for all landforms.
- Careful mine scheduling to ensure that NAF-oxide, alunitic-oxide and PAF waste rock streams are carefully managed and placed in accordance with the landform tip-to-design, and to minimise double handling.
- Develop a tracking system during mining to reconcile the location of the various waste rock streams within the landforms.
- Assess the potential for consolidation within the Grants Hill pit backfill to ensure that the drainage diversion continues to function as intended in the long term.
- Ensure maximum recovery of soil resources prior to ground disturbance to minimise the soil deficiency for rehabilitation.
- Detailed landform closure designs and associated construction documentation should be developed once the landforms have been tipped-out.

REFERENCES

Auralia Mining Consulting (2021). Personal communication – Email A. Keers. 19/8/2021.

Bureau of Meteorology (BoM) (2020a). Climate statistics for Australian locations – Nullagine. Available online: <http://www.bom.gov.au/climate/averages/tables/cw_004027_All.shtml>

Bureau of Meteorology (BoM) (2020b). Climate statistics for Australian locations – Marble Bar Comparison. Available online: <http://www.bom.gov.au/climate/averages/tables /cw_004020_All.shtml>

Bureau of Meteorology (BoM) (2020c). Climate statistics for Australian locations – Bonney Downs. Available online: <http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=136&p_display_type=dailyDataFile&p_startYear=&p_c=&p_stn_num=012066>.

Bureau of Meteorology (BoM) (2022). Design Rainfall Data System (2016) (coordinates 21.8625S 120.0875E) (issued 18/2/2022).

CSIRO (2020). Climate change in Australia: Projections for Australia's NRM regions – Rangelands North. Available online: <https://www.climatechangeinaustralia.gov.au/en/climate-projections/future-climate/regional-climate-change-explorer/sub-clusters/?current=RLNC&popup=true&tooltip=true>

Department of Primary Industries and Regional Development (2020a). Climate in the Pilbara region of Western Australia. Available online: <https://www.agric.wa.gov.au/climate-change/climate-pilbara-region-western-australia#:~:text=Rainfall%20in%20the%20Pilbara&text=Annual%20rainfall%20declines%20from%20300,least%20during%20winter%20and%20spring>

Department of Primary Industries and Regional Development (2020b). *Soil landscape mapping – Best available (DPIRD-027).* Available online: < https://services.slip.wa.gov.au/public/rest/services /SLIP_Public_Services/Soil_Landscape/MapServer/10>

360 Environmental (2021). Letter report titled "Proposed fresh rock expansion: pre-reading for technical briefing" addressed to EPA, DWER-Water and DMIRS. Dated 17 November 2021.

360 Environmental (2022). Mining proposal amendment – oxide expansion. Draft for internal review. Dated January 2022.

GARD Guide (2011). Global acid rock drainage guide. Available online: <http://www.gardguide.com/index.php?title=Main_Page>

Graeme Campbell and Associates (GCA) (2020a). Beatons Creek Gold Project – Geochemical assessment of mine-waste samples from the oxide-waste-zone and implications for mine-waste management. Unpublished report prepared for Novo Resources. Dated September 2020.

Graeme Campbell and Associates (GCA) (2020b) Water-Retention Testing of Oxide-[Surface-Zone]-Waste Samples BSX083, BSX086, BSX087, and BSX089. Unpublished report prepared Novo Resources. Dated 7 June 2020

Graeme Campbell and Associates (GCA) (2022). Beatons Creek Gold Project – weathering dynamics and solubility behaviour of fresh zone conglomerate waste samples for the fresh rock project. Unpublished report under preparation (not yet released) for Novo Resources.

International Council on Mining & Metals (ICMM) (2019). Integrated Mine Closure, Good Practice Guide, 2nd Edition.

International Network for Acid Prevention (INAP) (2017). Global cover system design – Technical guidance document.

Klohn Crippen Berger (KCB) (2018). Beatons Creek mine, hydrology modelling and flood mapping study. Unpublished letter report prepared for Novo Resources. Dated 9 August 2018.

Mine Earth (2017). Assessment of the physical properties of mine waste for the Beatons Creek Project. Unpublished memorandum prepared for Novo Resources. Dated November 2017.

Mine Earth (2018). Assessment of the erosion potential of waste rock from the Beatons Creek Project. Unpublished memorandum prepared for Novo Resources. Dated April 2018.

Mine Earth (2020). Assessment of the hydraulic characteristics of potential cover materials. Unpublished draft report (Revision A) prepared for Novo Resources. Dated October 2020.

Novo (2019a). NI 43-101 Technical Report: Mineral Resource Update, Beatons Creek Conglomerate Gold Project, Pilbara Region, Western Australia. Novo Resources Corp.

Novo (2019b). "Beatons Creek Mine Stratigraphy Catalogue." Internal presentation by Novo Resources Corp.

Novo pers.comm. (2022). Personal communication with Novo geologists, February 2022.

Okane (2021). Memorandum – Beatons Creek Gold Project, Conceptual cover system design. Unpublished memorandum prepared for Novo Resources. Dated 1 June 2021.

Pendragon Environmental Solutions (2015). Physical and chemical characterisation of soils and sediments – Beatons Creek Project. Unpublished report dated September 2015.

SRK Consulting (2018). Supplementary geochemical characterisation for Beatons Creek. Geochemical classification of samples from Beatons Creek. Unpublished report, Revision 1, dated 20 November 2018.

SRK Consulting (2021a). H3 hydrogeological Assessment Beatons Creek Gold Project (Draft). Unpublished report prepared for Novo Resources. Dated December 2021.

SRK Consulting (2021b). Technical memorandum – Beatons Creek pit surface water. Unpublished memorandum prepared for Novo Resources. Dated 9 April 2021.