Buller Plateaux Continuation Project Greenhouse Gas Assessment Report

Prepared for

Bathurst Resources Limited

July 2026

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Quality Control Sheet

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Limitations:

This report has been prepared for the exclusive use of our client Bathurst Resources Limited, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Recommendations and opinions contained in this report are based on the information reviewed as outlined in Section 3.5.1.

We understand and agree that our client will submit this report as part of an application under the Fast-track Approvals Act 2024 and that an Expert Panel as the consenting authority will use this report for the purpose of assessing that application.

We understand and agree that this report will be used by the Expert Panel in undertaking its regulatory functions in connection with Buller Plateaux Continuation Project.

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Executive Summary

Bathurst Resources Limited (BRL), Buller Coal Limited, Bathurst Coal Limited and BT Mining Limited (BTL) (together, "Bathurst") are seeking authorisation through the Fast-Track Approvals Act 2024 for the Buller Plateaux Continuation Project (The Project). Bathurst proposes to mine approximately 20 million tonnes of coal[1] from the Buller Plateaux. Mining and rehabilitation activities are proposed to occur for a 25-year period beginning in April 2027.

The coal is intended for export as coking coal in the hard-to-abate steel manufacturing sector and has characteristics that make it lower emitting than other alternative sources of coking coal.

The Project comprises five Project sub-areas, including:

- Stockton (including the Ngakawau Rail Loadout and Aerial Ropeway);
- Escarpment Extended (ESE);
- Mount Frederick South (MFS);
- Upper Waimangaroa Haul Road (UWHR); and
- Cypress (not in the scope of this assessment)[2].

Coal extraction from the Project sub-areas post 1 April 2027 is proposed to total approximately 16 million tonnes. The Stockton Coal Mining Licence (CML) expires on 31 March 2027, and for operations to continue, approval of the Project is required. The Project utilises Stockton's existing coal handling and processing infrastructure facilities and extends the mine life of the current Stockton operations over a 25-year time frame.

Bathurst engaged Pattle Delamore Partners Limited (PDP) to undertake a greenhouse gas (GHG) assessment for the proposed mining activities. This report provides an assessment of the Scope 1 and Scope 2[3] emissions across the 25-year period.

Scope 3 emissions are not within the boundaries set for this assessment. Bathurst has separately quantified Scope 3 emission savings from using NZ coal for international steel production, which is reported in Section 9.2 of the Technical Mining Report (Bathurst Resources Limited, 2026). The Technical Mining Report has been attached in Appendix A for reference.

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[1] 2026 onwards.

[2] Cypress is only included in the Project scope due to seeking the Wildlife Act Authority and a variation to compensation outcomes. All ongoing Cypress mining operations are otherwise consented and are therefore excluded from the assessment.

[3] Scope 1 emissions arise from activities directly owned or controlled by a company, while Scope 2 emissions are from purchased energy consumed by a company. Scope 3 emissions arise from activities associated with but not directly controlled by a company.

Net Scope 1 and 2 emissions from mining, processing and rehabilitation activities under the Project over 25 years are estimated to total 1,169,000 tonnes of carbon dioxide equivalent (t CO_2-e). The activities resulting in the greatest emissions are diesel usage by the vehicle fleet used for mining operations, which are 63% of total emissions (excluding land use change), followed by diesel use for support purposes including light vehicles, generators and pit pumping, which are 10% of total emissions (excluding land use change).

Table 1: Abbreviations

Abbreviation	Meaning
AMD	Acid Mine Drainage
ANFO	Ammonium Nitrate Fuel Oil explosive
AR5	Intergovernmental Panel on Climate Change Fifth Assessment Report
bcm	Bank cubic metres
BRL	Bathurst Resources Limited
BTM	BT Mining Limited
CHPP	Coal Handling and Processing Plant
CO_2-e	Carbon dioxide equivalent units of greenhouse gas emissions
DOC	Department of Conservation
ELF	Engineered Landform
ESE	Escarpment Extended sub-area
FTA	Fast-track approvals
FTE	Full Time Equivalent
FY	Financial Year
GHG	Greenhouse gas
GWP	Global Warming Potential
ha	Hectare
HAF	High potential for Acid Forming
IPCC	Intergovernmental Panel on Climate Change
km	Kilometre
LINZ	Land Information New Zealand
LULUCF	Land use, land use change and forestry
MfE	Ministry for the Environment
MFS	Mount Fredericks South sub-area
NAF	Non-Acid Forming
NZ ETS	New Zealand Emission Trading Scheme
NZU	New Zealand Units
PAF	Potentially Acid-Forming
PDP	Pattle Delamore Partners Limited
RMA	Resource Management Act 1991
UWHR	Upper Waimangaroa Haul Road sub-area
VDT	Vegetation Direct Transfer

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1.0 Introduction

1.1 Background

Bathurst Resources Limited and its subsidiary companies, together, "Bathurst" are seeking authorisations through the fast-track approvals legislation to continue and expand its mining operations across the Buller Plateaux. The purpose of the Buller Plateaux Continuation Project (the Project) is to secure the approvals necessary to retain the existing infrastructure and mining operations associated with the Stockton mine and provide access to additional mining areas across the Buller Plateaux.

This report is to be read in conjunction with the Sustainability, Energy Use and Greenhouse Gas Emissions – Buller Plateaux Continuation Project Report (Bathurst Resources Limited, 2025).

The Project is designed to enable coking coal resources to be mined allowing the continued use of existing infrastructure facilities over a 25-year timeframe proposed to commence from 1 April 2027. All coal extraction from the Project sub-areas post 1 April 2027 is proposed to total approximately 16 million tonnes[4]. PDP has assessed emissions for 16 million tonnes of coal extracted, based on the coal production schedule provided by Bathurst.

The purpose of the Fast-track Approvals Act 2024 (FTA Act) is to facilitate the delivery of infrastructure and development projects with significant regional or national benefits. The Project is listed in Schedule 2 of the FTA Act. For the FTA application, Bathurst has identified the need to consider climate change implications for the Project and to assess the Scope 1 and 2 greenhouse gas (GHG) emissions for the life of the Project.

Bathurst engaged Pattle Delamore Partners Limited (PDP) to estimate Scope 1 and Scope 2 GHG emissions for the life of the Project for the planned operations commencing April 2027. Scope 3 emissions are outside of the boundaries of this assessment. Bathurst has separately assessed Scope 3 emission savings associated with international steel production using the coal sourced from this Project. The savings are quantified in the Technical Mining Report attached in Appendix A.

[4] The project is proposed to extract approximately 20 million tonnes of coal between 2026 and 2042, however, this assessment is based on the coal produced from the project sub-areas post 2027, which is subject to the FTA consents. The remaining four million tonnes of coal is already consented under separate applications and therefore excluded from this assessment.

This Greenhouse Gas Assessment Report prepared for applications under the FTA Act includes consideration of:

- Operational GHG emissions (e.g., fuel use, energy consumption).
- Embodied GHG emissions (e.g., materials, construction, transport)[5].
- Mitigation strategies, such as carbon offsets or design changes to reduce emissions.

At a high level the Project has advantages for GHG emission reduction by utilising existing infrastructure, thereby reducing embodied carbon that would be associated with developing a new location. These savings have not been quantified.

1.2 Purpose

This GHG emission assessment provides a high-level estimate of the likely Scope 1 and Scope 2 GHG emissions associated with the Project starting 1 April 2027 and extending for 25 years.

This assessment is for the sole purpose of considering the potential effects of the proposal under the FTA Act and is not intended for use as part of reporting of the operational GHG emissions or for any other purpose.

1.3 Applicant and Site Description

The Project is within the Buller District, located approximately 15 km northeast of Westport. The site lies within an area which is predominantly used for existing coal mining activities and recreation. Historical coal mine workings are scattered throughout the Buller Plateaux. The mine spans across multiple parcels with various landowners.

1.4 Assessment Approach

Changes were made to the Resource Management Act 1991 (RMA) in November 2022 to enable regional and local authorities to consider the effects of resource consent applications on climate change.

Since GHG effects have relatively recently been included in the RMA, there is little policy or guidance for decision making under the RMA on projects with GHG emissions and few precedents for GHG assessments of effects.

[5] Embodied carbon is the total GHG emissions associated with materials and construction processes throughout the lifecycle of a built asset, including maintenance of that asset. Operational carbon differs from embodied carbon, being the GHG emissions generated while the asset is being used.

The Ministry for the Environment (MfE) published guidance (Ministry for the Environment, 2020) on how to assess GHG emissions and effects on climate change for applications under the COVID-19 Recovery (Fast-Track) Consenting Act (2020), noting that this act was repealed in July 2023.

The FTA Act does not provide any guidance on how GHG emissions should be assessed.

Due to the absence of further MfE guidance to replace the repealed COVID-19 Recovery Act, PDP has referenced the assessment approaches outlined in the Covid recovery fast track document. The MfE guidance (2020) indicates that where there is potential for significant adverse environmental effects, including GHG emissions, applicants must describe the anticipated and known adverse effects of the project on the environment, offering sufficient information to assess whether the project is likely to have:

1. A significant net *negative* emissions impact (resulting in an increase in emissions), or
2. A significant net *positive* emissions impact (resulting in a decrease in emissions), or
3. A minimal or uncertain emissions impact.

To demonstrate the emissions impact of GHGs from the proposed activity, PDP has estimated Scope 1 and Scope 2 emissions arising from coal mining activities[6] across relevant Project sub-areas[7].

1.5 New Zealand Emission Trading Scheme (NZ ETS)

The New Zealand Emissions Trading Scheme (NZ ETS) is a government tool with the aim of reducing GHG emissions to enable New Zealand to meet its international obligations for emissions reductions.

The NZ ETS requires a range of businesses (of which coal mines are included) to buy and surrender New Zealand Units (NZU) to the Government. One NZU is required for every tonne of CO_2 equivalent (CO_2-e) produced. The GHGs covered by the NZ ETS are:

- Carbon dioxide (CO_2);
- Methane (CH_4);
- Nitrous oxide (N_2O);
- Sulphur hexafluoride;
- Hydrofluorocarbons; and

[6] Coal mining activities include stripping of overburden, coal extraction, coal processing, gravel extraction, rehabilitation activities and ancillary activities including wastewater treatment, staff movements, and workshop support etc.

[7] Note that Cypress is not included in the FTA or this assessment as the Cypress pit has consents for the life of the mine related to a Mining Permit (MP), which are not related to the Stockton CML expiry.

- Perfluorocarbons.

Bathurst is a participant under the NZ ETS, remitting carbon units for GHG emissions that result directly from its mining activities and for the combustion of its coal[8] used in New Zealand[9]. The NZ ETS specifically exempts coal sold internationally, this is because combustion occurs in overseas jurisdictions, which are responsible for those emissions.

In addition to purchasing GHG emissions credits, landowners with forested areas or rights to such land can generate carbon credits. Bathurst currently has 414.5 hectares (ha) of forested area registered under the NZ ETS, and this will increase as rehabilitation of the Buller Plateaux progresses.

This assessment estimates the total CO_2-e emissions across the Project, bearing in mind that Bathurst is already responsible for the relevant NZU purchases for these emissions via the NZ ETS. The NZ ETS uses an “upstream” point of obligation, meaning that the first entity to create or import a product that results in GHG emissions is responsible for reporting and paying for those emissions, rather than the end user. Bathurst currently surrenders NZUs for diesel, petrol and fugitive coal seam emissions from its coal mining activities. Bathurst is not required to surrender NZUs for its electricity use because the electricity supplier has already accounted for those emissions in its reporting.

As noted above this assessment is for FTA consenting purposes and is therefore separate from Bathurst’s reporting obligations under the NZ ETS.

2.0 Description of Proposed Activity

Bathurst is proposing to access coal mining areas across the Buller Plateaux for the coal export market. Coal winning is estimated to be complete by 2042 based on anticipated demand. Following extraction of the coal, Bathurst will rehabilitate the Project footprint, with the majority of the areas being replanted in indigenous vegetation or otherwise rehabilitated using alternative species and resources (for example, boulders, rock and logs) suited to the particular characteristics of the site (i.e., altitude, slope and drainage).

2.1 Layout of the Buller Plateaux Project

The Project comprises five Project sub-areas, including:

- Stockton (including the Ngakawau Rail Loadout and Aerial Ropeway);
- Escarpment Extended (ESE);
- Mount Frederick South (MFS);
- Upper Waimangaroa Haul Road (UWHR); and

[8] Bathurst does not burn the coal it sells, however, under the NZ ETS Bathurst is responsible for reporting the emissions from the combustion of that coal within New Zealand and purchasing the required units for that combustion under the NZ ETS.

[9] Bathurst Resources Limited, *Emission Trading Scheme Policy v4.0,* October 2017.

- Cypress (excluded from this assessment).

Cypress is an existing and currently operational mine, with all future operations consented. Coal extraction from Cypress is not included in the 16 million tonnes of coal extraction assessed in this report[10].

The location of these sub-areas is presented in Figure 1 below. Cypress is outlined in green to the southeast of Stockton. The light grey shading indicates the existing land disturbance from the currently consented Stockton Mine. Proposed areas of disturbance under the Project are shaded in pink, with the proposed consent boundary outlined in light yellow.

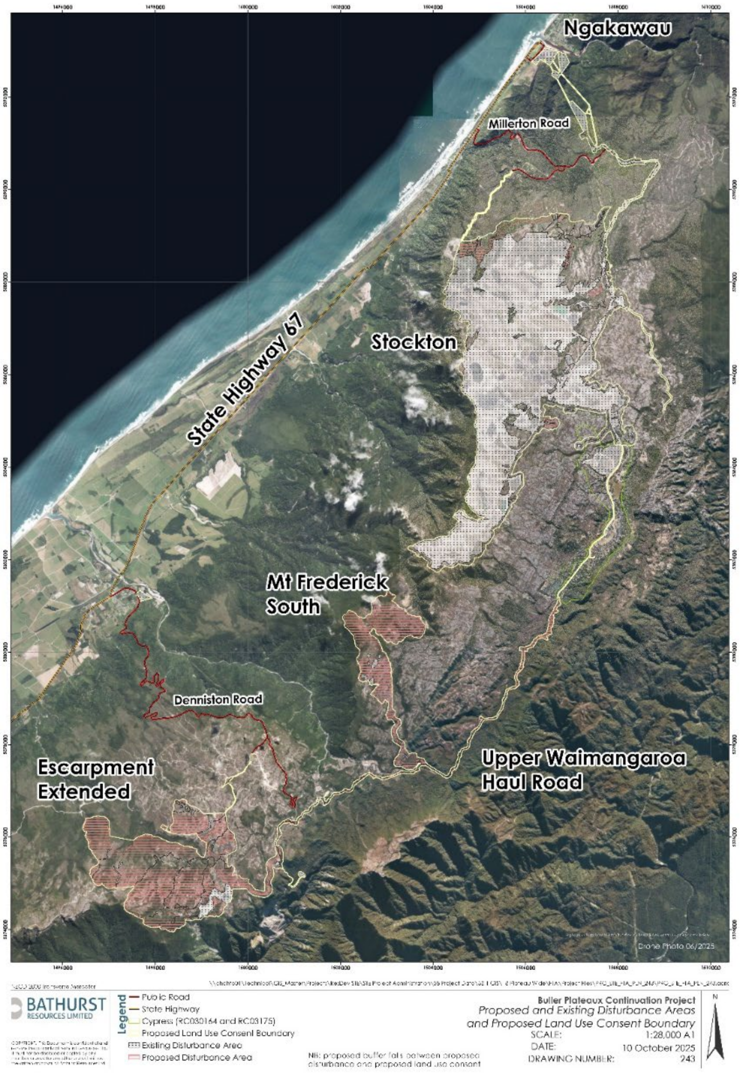

Figure 1: Proposed and Existing Disturbance Areas and Proposed Consent Boundary of the Project (Bathurst Resources Limited, 2025)

[10] It is understood that a variation is being sought for this area under the FTA, but it does not relate to mining activities.

Appendix B illustrates the historic underground workings on the Buller Plateaux, showing the area has been extensively mined underground. Even if the area is not open cast mined as proposed under the Project, the historic underground workings will continue to produce fugitive coal seam GHG emissions. Approximately 188 ha of historic workings fall within the proposed Project footprint, most of which will currently be emitting fugitive coal seam GHG emissions. These fugitive coal seam emissions are outside the scope of this assessment. Once mining of the Project sub-areas is complete, these fugitive coal seam GHG emissions will no longer be occurring.

2.2 Proposed Future Operations

Coal mining operations across all Project sub-areas are proposed to follow the standard open pit methodology (drill and blast, load and haul). No underground mining is proposed.

Excluding Cypress, approximately 16 million tonnes of coal are proposed to be extracted across the life of the Project (commencing 1 April 2027 and continuing for 25 years). Projected coal production by sub-area is presented in Figure 2, with a more detailed annual breakdown provided in Appendix C.

Coal produced from the ESE and MFS sub-areas will be trucked along the UWHR to the fully electrified existing Coal Handling and Processing Plant (CHPP) at Stockton Mine. A single processing area is required because the coal properties differ across the Buller Plateaux, therefore coal from different Project sub-areas must be processed to meet specifications. Because the CHPP is existing, no new equipment is required for coal processing. Coal is then trucked along a 7.4 km haul road before being transported to the Ngakawau Rail Loadout Facility via the Aerial Ropeway. The Aerial Ropeway produces a small quantity of electricity during normal operations[11]. Coal is transported by rail from Ngakawau to Lyttelton Port for export.

[11] Due to the energy created during braking.

[redacted]

Waste rock (overburden) produced during mining operations will be graded into non-acid forming (NAF), possibly acid-forming (PAF) and high acid forming (HAF) potentials. Waste rock will be disposed within engineered landforms (ELFs) based on rock grades to backfill previously mined areas, minimising acid production. After mining operations have finished, all Project sub-areas will be rehabilitated.

2.2.1 Stockton

Operations in the Stockton sub-area are proposed to continue in the A Drive, Rockies North, Hope-Lyons and Millerton (East and West) pits, as shown in Figure 3. Approximately 11 ha of the proposed Stockton disturbance area has previously been disturbed by historic workings.

Aggregate production within the existing A Drive Borrow Pit is proposed to continue, supplying aggregate for haul road construction, including the UWHR. The proposed operations will continue to utilise existing facilities and infrastructure at Stockton and Ngakawau. Water and Acid Mine Drainage (AMD) treatment across the site is proposed to continue in a similar manner as existing Stockton operations.

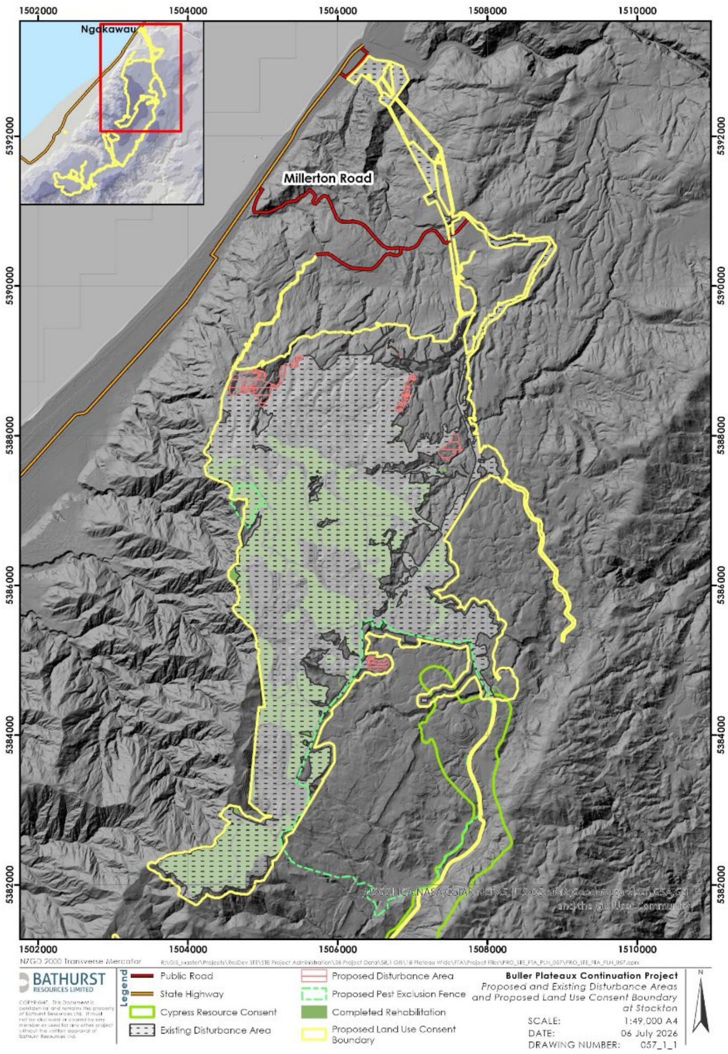

Figure 3: Proposed Stockton sub-area footprint (Bathurst Resources Limited, 2026)

2.2.2 Mount Frederick South

Figure 4 shows the MFS sub-area, which is located approximately 1 km southwest of the existing Mount Frederick mining area within the existing Stockton Mine footprint. The land within the MFS footprint is owned by the Crown and administered by the Department of Conservation (DOC) and Land Information New Zealand (LINZ). Historic underground coal mining activity within the MFS sub-area has resulted in areas of disturbance and subsidence. Approximately 14 ha of historical mine workings fall within the proposed MFS disturbance footprint. Coal resources are relatively shallow in this area.

Access to the MFS sub-area will require the construction of an MFS access road branching off the proposed UWHR. The MFS access road will be 3.4 km long and will include a bridge to cross Deep Creek.

Where possible, mining equipment will be sourced from surplus machinery at Stockton or from other mining operations owned by the applicant[12]. If required, new equipment will be purchased.

Infrastructure requiring construction within the MFS sub-area includes:

- Open mining pits MFS East and MFS West;
- Access road to the MFS sub-area and haul roads between mine elements;
- Overburden ELFs;
- Coal stockpile area;
- Waste management infrastructure;
- Water treatment plant; and
- Semi-permanent small staff crib room.

Most of the infrastructure construction will be undertaken by external contactors.

[12] For example, Rotowaro Mine and Takitimu Mine.

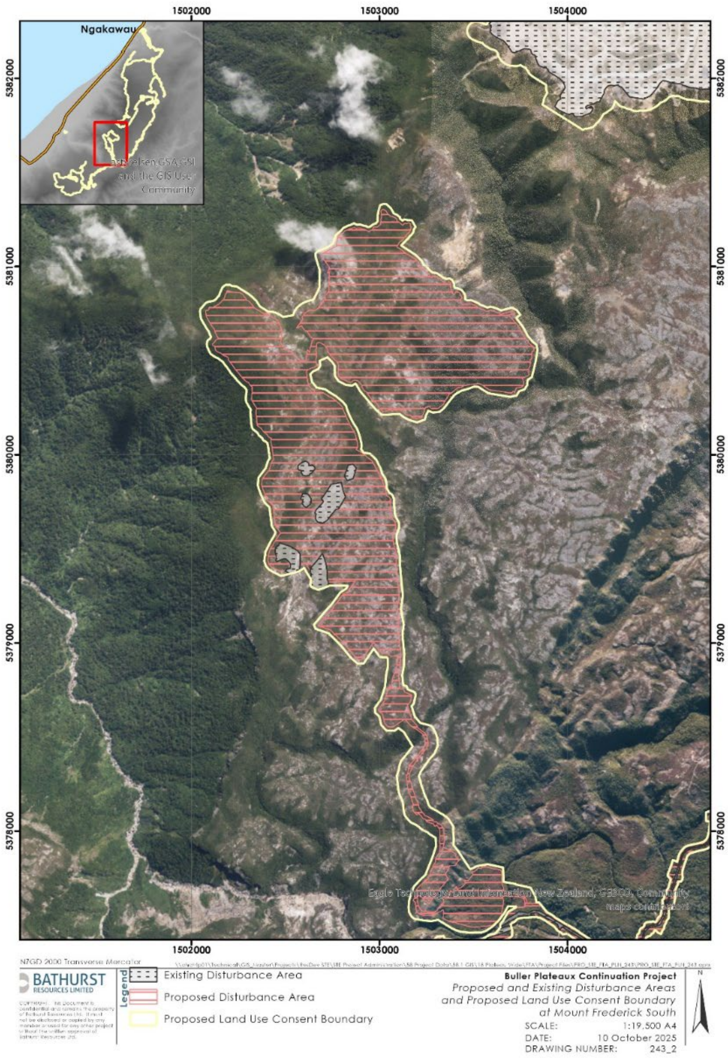

Figure 4: Proposed MFS sub-area footprint (Bathurst Resources Limited, 2025)

2.2.3 Escarpment Extended

Figure 5 shows the ESE Project sub-area, which is the southernmost sub-area of the Project, located on the Denniston Plateau. The Denniston Plateau has historically been extensively mined underground. The land is owned by the Crown and is administered by DOC, falling into the Mount Rochfort Conservation Area. Currently the sub-area is accessed via Denniston Road. As part of this Project, a link to Stockton will be constructed via the UWHR to facilitate processing at the CHPP.

The ESE Project sub-area includes the existing Escarpment Mine, which was moved into care and maintenance operations in 2016 and for which new approvals for care and maintenance have been lodged; and the Waimangaroa Storage Yard, which is located at the bottom of Denniston Road. Historic mine workings constitute approximately 156 ha of the proposed ESE disturbance footprint.

As with the other sub-areas, new infrastructure and facilities apart from the new coal pits will be constructed by contractors. Some of this infrastructure includes:

- Open mining pits covered by Mining Permits MP51279 (Escarpment Mine), MP60138 (Whareatea West) and the Sullivan Coal Mining Licence (CML37161);
- Haul roads connecting mine elements;
- Central infrastructure including a warehouse, workshops, maintenance and fuelling facilities, a tyre bay, equipment washdown area and water treatment facilities; and
- Administration office area.

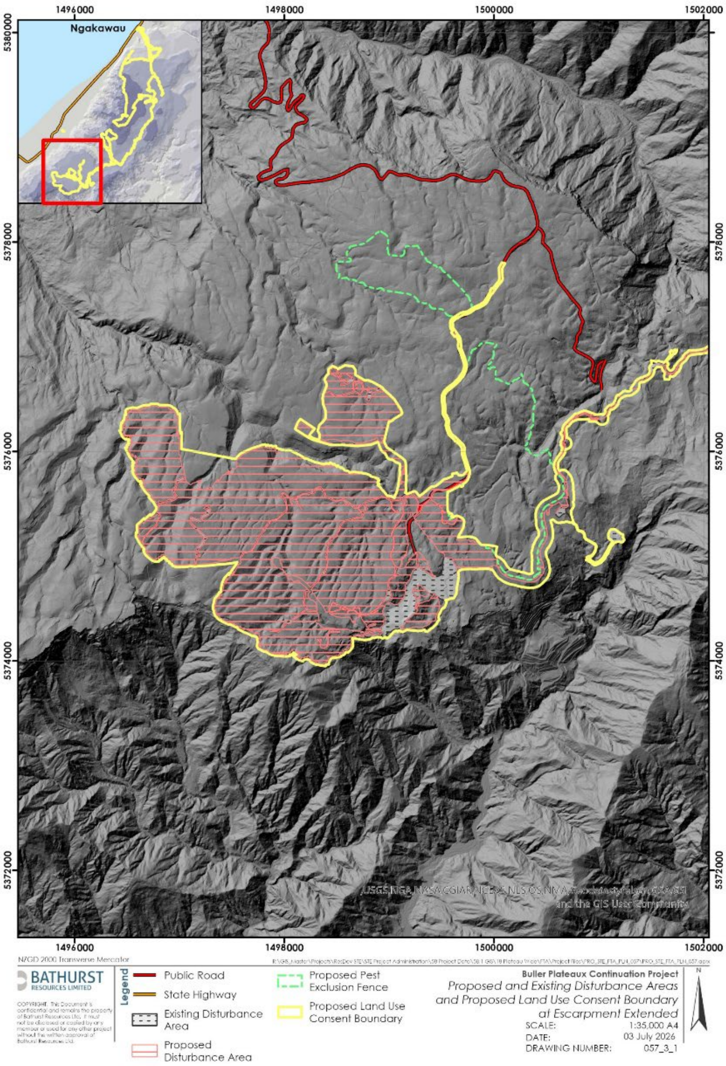

Figure 5: Proposed ESE sub-area footprint (Bathurst Resources Limited, 2026)

2.2.4 Upper Waimangaroa Haul Road

The UWHR will connect existing Stockton infrastructure with the Denniston Plateau, passing through the Cypress Mine area. The UWHR will be 14 km long by 8.6 m wide (operating width) and unsealed. Note that an additional 5 km of haul road will be constructed from the Stockton CML/mining permit boundary (the official end of the UWHR) to the CHPP, which has been included in the calculations. Approximately 4 km of the UWHR covers undisturbed ground, with around 7 ha within the proposed UWHR footprint already disturbed. Existing haul roads and 4WD tracks will be upgraded where possible. Construction is expected to take between 18 months and 2 years to complete. Construction will be carried out by contractors using aggregate from the A Drive Borrow Pit.

2.3 Operational Hours

Mining operations are proposed to be 24 hours per day, 7 days a week.

The Aerial Ropeway will transport all coal produced across the life of the Project (including processed coal from Cypress) from the CHPP to Ngakawau. The ropeway typically operates between 7 am and 1 am, 5 days a week, however, this could change depending on coal demand and could be up to 24 hours per day, 7 days per week.

3.0 Assessment Methodology

3.1 Overview

PDP has undertaken this GHG assessment to quantify emissions and removals using ISO 14064-1:2018 (International Organization for Standardization, 2018) and the GHG Protocol (Greenhouse Gas Protocol, 2025) methods. The assessment represents the current project[13] envelope for the Scope 1 and 2 activities that will contribute to GHG emissions associated with the Project.

Guidance and standards referenced in undertaking this assessment were from the following sources:

- Ministry for the Environment's 'Measuring Emissions: A guide for organisations – 2024 detailed guide' (Ministry for the Environment, 2024);
- New Zealand Legislation's 'Climate Change (Stationary Energy and Industrial Processes) Regulations 2009' (New Zealand Legislation, 2009) (updated 1 January 2025); and,

[13] Some of the GHG emissions are calculated based on data for the existing operation and are likely to vary over time due to actual production levels and operational parameters for each sub-area.

- International Organization for Standardization's 'Specification with guidance at the organisation level for quantification and reporting gas emissions and removals' (International Organization for Standardization, 2018); and,
- Water New Zealand's Carbon Accounting Guidelines for Wastewater Treatment: CH_4 and N_2O (Water New Zealand, 2021).

3.2 Emissions Factors

In accordance with good practice, where possible, emission factors were sourced from MfE's Measuring Emissions: A Guide for Organisations – 2025 Emission Factor Workbook (Ministry for the Environment, 2025). These factors are based on the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5) (IPCC, 2014).

The emission factor for fugitive coal seam gas[14] used measurement data from testing of coal samples from a drillhole at MFS (Geosciences, 2025) as calculated by Rob Boyd[15]. Appendix D presents Rob Boyd's calculations for determining the unique emission factor.

Emission factors for explosive use were sourced from Bathurst[16].

Table 2 presents a summary of the emissions factors used for this assessment.

[14] Fugitive emissions are defined by MfE as the unintended release of gases, usually from industrial activities (Ministry for the Environment, 2024).

[15] Rob Boyd, *Buller Project Coals – Towards a Unique Emission Facotr,* Emailed from Rob Boyd dated 20 July 2026.

[16] The emission factor for ANFO explosive use was provided by Bathurst and is consistent with literature (BHP Billiton Mitsubishi Alliance, 2009).

Table 2: Emission Factors (kg CO_2-e per unit)					
Emission Type and Unit	**Source**	**Total**	**CO_2**	**CH_4**	**N_2O**
Fugitive coal seam gas (tonne coal)	Bathurst[17]	6.2	-	6.2[18]	-
Ammonium Nitrate Fuel Oil (ANFO) explosive (tonne ANFO powder)	Bathurst	180.0			
Limestone - Waste Rock Disposal (kg limestone)	PDP Calculation[19]	0.44	0.44	-	-
Electricity (kWh)	(Ministry for the Environment, 2025)	0.10	0.010	0.00	0.00
Diesel - Stationary (L)		2.67	2.66	0.00	0.01
Diesel – Transport (L)		2.68	2.64	0.00	0.04
Heavy Fuel Oil (L)		3.06	3.04	0.01	0.02
Petrol (L)		2.38	2.28	0.03	0.07
Diesel – Freight - Equipment Relocation (km)		1.54	1.51	0.00	0.02
Deforestation – Post-1989 Regenerating Natural Forest (ha)		141,350	141,350	-	-
Reforestation – Post-1989 Regenerating Natural Forest (ha/year)		-7,973	-7,973	-	-
Domestic Wastewater Treatment – Septic Tanks		175.2	-	149.9	25.3

[17] The fugitive coal seam gas emission factor provided by Bathurst is significantly lower than the default emission factor of 24.0 kg $CO_{2\text{-}e}$ provided in Table 3 of the Climate Change (Stationary Energy and Industrial Processes) Regulations 2009 (New Zealand Legislation, 2009). PDP considers that using the emission factor provided by Bathurst is likely a more accurate representation of the fugitive coal seam emissions produced from the Buller Plateaux.

[18] The fugitive emission factor was provided by Bathurst based on gas desorption tests by Strata Geosciences (Appendix D).

[19] The maximum stoichiometric CO_2 emission release from pure limestone was used in preference to the MfE emission factor for limestone used as agricultural fertiliser, due to large uncertainties associated with using an emission factor for an unintended application.

3.3 Global Warming Potentials

GHGs such as CO_2, N_2O, and CH_4 have varying heat-trapping capacities, resulting in different impacts on climate change. The MfE uses global warming potential (GWP) factors over a 100-year period to measure the relative warming impact for various GHGs, which are reported as CO_2-e.

ISO 14064-1:2018 recommends using the latest IPCC GWPs. MfE's guidance (at the time of writing) uses the IPCC Fifth Assessment Report (AR5) GWPs, aligned with the National Inventory approach. Table 3 provides AR5 GWPs for converting emissions of the GHGs being assessed to CO_2-e.

Table 3: Global Warming Potential (GWP) of GHGs over a 100-Year Period

GHG	Scientific Formula	GWP (AR5)
Carbon dioxide	CO_2	1
Methane	CH_4	28
Nitrous oxide	N_2O	265

3.4 Data Collection and Uncertainties

MfE uses the following approaches to disclosing uncertainty in emission factors and recommends applying the same approach to activity data, in order of preference:

1. The quantified uncertainty if known.
2. The qualitative uncertainty if known, based on expert judgement from those providing the data.
3. Uncertainty ranges as in the IPCC Guidelines if provided.
4. That the uncertainty is unknown.

Regarding the emission factors, uncertainties are mostly unknown and not quantified. PDP has qualitatively assessed the uncertainty of the activity data has been in Section 3.5.1 of this report.

3.5 Reporting Boundaries

Emissions are classified into scopes based on their origin and control. The Greenhouse Gas Protocol introduced three scopes, which are summarised as follows:

- **Scope 1:** Direct emissions from sources owned or controlled by a company.
- **Scope 2:** Indirect emissions from purchased electricity, heating, or cooling consumed by a company.
- **Scope 3:** Indirect emissions from activities in a company's value chain, including upstream and downstream sources outside of the company's control.

The Project assessment includes Scope 1 and Scope 2 emissions. While Scope 3 emissions were excluded from the study boundaries, Scope 3 emissions savings from using Buller Plateaux coal over some international coals are discussed in the Technical Mining Report produced by Bathurst.

3.5.1 GHG Emission and Removal Source Inclusion

Bathurst has provided activity data for the expected emissions sources for the relevant emission scopes. Table 4 sets out the GHG sources included in this assessment and discusses uncertainty relating to the activity data.

Emissions arising from contractor operations (including rehabilitation and construction of infrastructure) are classified as Scope 3, however, Bathurst provides diesel to contractors. GHG emissions arising from the use of fuel provided by Bathurst are therefore classified as Scope 1, regardless of who uses the fuel. However, due to insufficient information on how much fuel the contractors will use, these GHG emission have not been calculated.

Emissions from land use, land use change and forestry (LULUCF) activities are typically only considered Scope 1 if the land is owned by the reporting entity. Emissions from the removal and replanting of vegetation within the Stockton Project sub-area are therefore within Scope 1.

While Bathurst does not own the land occupied by the footprint of the other sub-areas, Bathurst does directly control the emissions due to the removal and replanting of vegetation at MFS, ESE and for the UWHR and MFS access road. Bathurst also owns and will operate the machinery that will be used for deforestation and reforestation purposes. Therefore, LULUCF activities at MFS, ESE, the UWHR and the MFS access road have been considered as Bathurst's Scope 1 emissions for this assessment.

PDP has assumed that emissions associated with LULUCF activities do not include emissions from the fuel used for these activities because these emissions are already captured in the projected fuel usage.

Table 4: Activity Data for Emission and Removal Sources within the Assessment Boundary

GHG Emission / Removal Source	GHG Emission / Removal Scope	Data Source	Data Collection Unit	Uncertainty (Description)
Fugitive coal seam gas	Scope 1 (anthropogenic, non-biogenic)	Proposed mining schedule (Bathurst Resources Limited, 2025)	Tonne coal	Data on the weight of coal produced relies on the accuracy of the mining schedule provided by Bathurst.
In-pit transport, processing, & pumping – diesel	Scope 1 (anthropogenic, non-biogenic)	Proposed mining schedule, predicted diesel usage schedule and historical diesel usage (Bathurst Resources Limited, 2025)	Litre diesel	In-pit diesel usage for Stockton has been estimated from historical averages and scaled linearly based on expected future coal production. Historical diesel usage is assumed to include all diesel supplied to contractors by Bathurst (making the fuel use Scope 1). Diesel usage includes all typical mining activities such as coal winning, overburden stripping and associated deforestation, some progressive rehabilitation and associated revegetation, aggregate production at the A Drive Borrow Pit and vehicle movements within the Stockton sub-area. Predicted diesel usage for ESE and MFS sub-areas has been provided directly by Bathurst. Diesel emissions from in-pit operations rely on accuracy of predicted fuel usage provided by Bathurst.
Coal haul transport	Scope 1 (anthropogenic, non-biogenic)	Predicted diesel usage schedule (Bathurst Resources Limited, 2025)	Litre diesel	Emissions from coal haul rely on accuracy of predicted fuel usage provided by Bathurst. Coal haul fuel usage is assumed to include haul along UWHR, ESE and MFS access roads, as well as coal haul from the CHPP to the start of the Aerial Ropeway.

Table 4: Activity Data for Emission and Removal Sources within the Assessment Boundary

GHG Emission / Removal Source	GHG Emission / Removal Scope	Data Source	Data Collection Unit	Uncertainty (Description)
Transport - petrol	Scope 1 (anthropogenic, non-biogenic)	Proposed mining schedule and historical petrol usage (Bathurst Resources Limited, 2025), (Bathurst Resources Limited, 2025)	Litre petrol	In-pit petrol usage has been estimated from historical Stockton data and scaled linearly based on expected future coal production for each coal pit. Petrol usage for maintenance of the UWHR, for coal haul and for other support purposes is expected to be negligible and was therefore not estimated.
Transport – heavy oil	Scope 1 (anthropogenic, non-biogenic)	Proposed mining schedule and historical heavy oil usage (Bathurst Resources Limited, 2025), (Bathurst Resources Limited, 2025)	Litre heavy oil	In-pit heavy oil usage has been estimated from historical averages for the existing pits and scaled linearly based on expected future coal production. Heavy oil usage for maintenance of the UWHR, for coal haul and for other support purposes is expected to be negligible and was therefore not estimated.
Electricity	Scope 2 (anthropogenic, non-biogenic)	Proposed mining schedule, historical electricity usage and typical electricity usage breakdown[20] (Bathurst Resources Limited, 2025), (Bathurst Resources Limited, 2025)	kWh electricity	In-pit electricity usage has been estimated from historical averages and scaled linearly based on coal production tonnages (excludes Cypress). This is assumed to include electricity used for pumping water, wastewater and chemical dosing units. For simplicity, electricity emissions from coal processing have been reported for each sub-area despite the CHPP being located within Stockton. Electricity used at the CHPP, for transport to Ngakawau and at Ngakawau has been calculated separately from in-pit usage using the same methodology. It should be noted that the Aerial Ropeway produces a small quantity of electricity during normal operation due to the braking required.

[20] Breakdown of typical electricity usage for Stockton was provided from email correspondence with Bathurst.

Table 4: Activity Data for Emission and Removal Sources within the Assessment Boundary

GHG Emission / Removal Source	GHG Emission / Removal Scope	Data Source	Data Collection Unit	Uncertainty (Description)
Blasting	Scope 1 (anthropogenic, non-biogenic)	Predicted explosive usage for coal pits and A Drive Borrow Pit.[21]	Tonne ANFO explosive	Blasting emissions are reliant on the accuracy of information provided by Bathurst. Diesel usage for ANFO explosive is assumed to be negligible (comprising approximately 6% by weight).
Rehabilitation – Diesel	Scope 1 (anthropogenic, non-biogenic)	Predicted diesel usage schedule, diesel rehabilitation factor, proposed rehabilitation schedule and historical diesel usage provided by Bathurst (Bathurst Resources Limited, 2025), (Bathurst Resources Limited, 2026)	Litre diesel	Predicted diesel usage for progressive rehabilitation in the MFS and ESE pits was provided by Bathurst. Predicted diesel usage for progressive rehabilitation in the Stockton pit was estimated based on the scheduled rehabilitation areas and a diesel usage per area factor provided by Bathurst[22]. Total rehabilitation activities occurring post coal winning operations ending Financial Year 2042 (FY42) were estimated based on remaining areas requiring rehabilitation and a diesel usage per area factor provided by Bathurst. Diesel emissions from rehabilitation are reliant on the accuracy of information provided by Bathurst.

[21] Predicted explosive usage, predicted aggregate production and the powder factor were all provided from e-mail correspondence with Bathurst (August 2025).

[22] Historically, some progressive rehabilitation has occurred, which means that the pro-rated in-pit diesel use will double-count diesel use for progressive rehabilitation, in the Stockton pit only. In FY28, diesel used for rehabilitation (as estimated using the rehabilitation schedule) constituted 2% of in-pit diesel use at Stockton, which is considered negligible. As coal production in the Stockton pit decreases, the impact of the double-counting will reduce.

Table 4: Activity Data for Emission and Removal Sources within the Assessment Boundary

GHG Emission / Removal Source	GHG Emission / Removal Scope	Data Source	Data Collection Unit	Uncertainty (Description)
LULUCF – Emissions from Deforestation	Scope 1 (anthropogenic, biogenic)	Proposed disturbance footprint schedule provided by Bathurst[23] (Bathurst Resources Limited, 2026), (Bathurst Resources Limited, 2026)	Ha forest disturbed (less VDT)	Disturbance areas for each sub-area were considered to be primarily covered in Post-1989 Regenerating Natural Forest, based on aerial imagery and 2012 land cover data (Manaaki Whenua Landcare Research, Accessed 2025)[24]. From the calculated forested area, the disturbed area associated with Vegetation Direct Transfer (VDT) was excluded, as VDT does not contribute to a net change in GHG emissions. VDT information was supplied by Bathurst.
LULUCF – Removals from Reforestation	Scope 1 (anthropogenic, biogenic)	Proposed rehabilitation footprint schedule (Bathurst Resources Limited, 2026)	Ha forest rehabilitated (less VDT)	All rehabilitated areas were assumed to be planted in native vegetation within a year of the rehabilitation earthworks. Areas used for VDT were considered to be mature forest and therefore not contributing to net GHG removal from the atmosphere. Rehabilitation footprints are reliant on the accuracy of information provided by Bathurst. All rehabilitated areas are to be planted in native vegetation or otherwise rehabilitated using alternative resources such as boulders and logs suited to the nature of the site.

[23] Updated Stockton disturbance areas were provided to PDP via direct email correspondence on 8 July 2026.

[24] PDP has used the most relevant information provided to determine LULUCF emissions, however, this is subject to change depending on the actual area and the type of vegetation removed.

Table 4: Activity Data for Emission and Removal Sources within the Assessment Boundary

GHG Emission / Removal Source	GHG Emission / Removal Scope	Data Source	Data Collection Unit	Uncertainty (Description)
On-site Wastewater Treatment	Scope 1 (anthropogenic, biogenic)	Staffing numbers (Bathurst Resources Limited, 2025)	FTE staff	Wastewater is treated onsite, primarily through small, prefabricated treatment systems disposing to land or septic systems disposing to sand beds. In the absence of data on whether the small treatment systems produce similar emissions to typical municipal wastewater treatment plants, PDP has assumed the emission factor for septic treatment systems. Emissions from wastewater treatment rely on the accuracy of FTE staffing numbers supplied by Bathurst.
Limestone – Waste Rock Disposal	Scope 1 (anthropogenic, non-biogenic)	Estimated limestone usage schedules (Bathurst Resources Limited, 2025), (Bathurst Resources Limited, 2025)	Kg limestone	Limestone is sometimes mixed with acid-forming waste rock before being placed in ELFs to reduce acid formation. The calculation assumes that all limestone applied is pure $CaCO_3$ and that all carbon in the limestone is reacted to CO_2. Emissions from neutralisation rely on the accuracy of predicted limestone usage provided by Bathurst.
Relocation of Bathurst or subsidiary owned mining equipment to the Buller Plateaux - Diesel	Scope 1 (anthropogenic, non-biogenic)	Equipment sourcing plan (Bathurst Resources Limited, 2025)	Number and location of mining equipment	All mining equipment was assumed to be transported to the Buller Plateaux via truck. The number and location of mining equipment was converted to diesel emissions based on the two-way distance travelled.

3.5.2 GHG Emission Source Exclusions

Table 5 summarises the key sources of GHG emissions that were excluded from the GHG assessment[25]. Most exclusions are Scope 3 emissions that fall outside the assessment boundary for this report.

Table 5: Emission Sources and Removals Excluded from the Assessment Boundary

GHG Emission / Removal Source	GHG Emission / Removal Scope	Description and Reason for Exclusion
LULUCF removals for Stockton vegetation planted before 1 April 2027.	Scope 1 (anthropogenic biogenic)	Emission removals (carbon sinks) from vegetation planted due to rehabilitation activities before 1 April 2027 will continue to sequester carbon throughout the life of the Project. However, these have not been considered because rehabilitation activities before April 2027 are already approved and the emission removals would continue to occur regardless of Project activities related to the FTA application.
New infrastructure and facilities	Scope 3 (anthropogenic non-biogenic)	The construction of all new infrastructure proposed including buildings and roads will be undertaken by third party contractors, resulting in a Scope 3 classification.
Contractor fuel use for construction of new infrastructure	Scope 1 (anthropogenic non-biogenic)	The applicant supplies fuel to external contractors (therefore the fuel usage is Scope 1), however, this has not been estimated due to insufficient fuel usage information related to the construction of new infrastructure.
Decomposition of on-site landfill materials	Scope 1 (anthropogenic, primarily non-biogenic)	The applicant is not proposing to landfill any waste materials post April 2027 and instead will use contractors to remove all waste and recycling from the site. No new landfills will be formed.

[25] Note that this list does not include all Scope 3 emission categories as this is outside the scope of the assessment boundaries.

Table 5: Emission Sources and Removals Excluded from the Assessment Boundary

GHG Emission / Removal Source	GHG Emission / Removal Scope	Description and Reason for Exclusion
Electricity transmission and distribution losses	Scope 3 (anthropogenic non-biogenic)	Electricity transmission and distribution losses are Scope 3 and are considered negligible.
AMD Wastewater	Scope 3 (anthropogenic non-biogenic)	Acid Mine Drainage (AMD) neutralisation, flocculation and chelation do not contribute direct atmospheric emissions. The carbon footprint associated with the production of the chemicals through the AMD process is Scope 3 and is excluded from the assessment. Coal wash wastewater does not contribute emissions.
Production of Chemical Dosing for Water and Wastewater	Scope 3 (anthropogenic, non-biogenic)	Emissions contributing to the production of calcium oxide (AMD neutralisation), flocculant, chelation chemicals and chlorine (or other disinfection products) for potable water supply are Scope 3, because Bathurst do not manufacture these chemicals. Use of these chemicals does not result in quantifiable GHG emissions.
Fuel use for chemical transport	Scope 3 (anthropogenic, non-biogenic)	Insufficient information is available regarding the transport of water and wastewater treatment chemicals on site. It is assumed that chemical suppliers deliver to site, so these emissions are considered Scope 3.
Embodied carbon associated with new mining equipment	Scope 3 (anthropogenic, non-biogenic)	New mining equipment is not manufactured by Bathurst, therefore it is classified as Scope 3. The method and distances of transporting new mining equipment to site is unknown. There is insufficient information available to assess the emissions associated with this activity, therefore transport emissions for new machinery have been excluded.

Table 5: Emission Sources and Removals Excluded from the Assessment Boundary

GHG Emission / Removal Source	GHG Emission / Removal Scope	Description and Reason for Exclusion
Cypress Operations	Scope 1 (anthropogenic, primarily non-biogenic)	Cypress is only included in the Project scope due to seeking the Wildlife Act Authority and a variation to compensation outcomes. All Cypress mining operations are otherwise already consented and are therefore excluded from the assessment.
Fugitive coal seam emissions from historical underground workings	Scope 1 (anthropogenic, non-biogenic)	Fugitive coal seam GHG emissions from historical workings are not a result of operations proposed under the Project and are therefore excluded from this assessment.

3.6 Activity Data and Assumptions

Bathurst supplied data that was directly used in this assessment; the data is provided in Appendix C[26]. Data supplied is broken down by annual usage where possible. This data includes the following:

- Historical Stockton coal production;
- Historical Stockton and Ngakawau diesel usage;
- Historical Stockton heavy oil usage;
- Historical Stockton petrol usage;
- Historical Stockton electricity usage;
- Breakdown of historical electricity usage by source;
- Proposed coal production schedule, where coal is produced between FY28 and FY42;
- Predicted diesel usage schedule for MFS operations, ESE operations, UWHR maintenance, progressive rehabilitation operations at MFS and ESE, and support operations based on equipment sourcing plan;
- Predicted stripping and rehabilitation schedule for Stockton;
- Predicted stripping and rehabilitation schedule for MFS;
- Predicted stripping and rehabilitation schedule for ESE;

[26] Any discrepancy in activity data (supplied by Bathurst in financial years running 1 July – 30 June) and the Project timeframes (starting 1 April 2027 and running until 31 March 2042) is assumed to be negligible.

- Diesel use per rehabilitated area factor;
- Staffing numbers for Stockton, ESE and the Denniston Plateau;
- Predicted limestone usage schedule for MFS and ESE (note no limestone is added to waste rock at Stockton); and
- Predicted explosive usage for Stockton, MFS and ESE sub-areas.

Fugitive coal seam emissions from open-cast coal mining have been estimated for each Project sub-area based on the predicted coal production schedule.

Diesel emissions across the Project were estimated using the predicted fuel usage schedule, except for diesel usage within the Stockton sub-area as this data was not supplied. For Stockton, historical diesel usage data was pro-rated to estimate future in-pit diesel emissions. Heavy oil and petrol usage was pro-rated across all coal mining pits. Diesel, heavy oil, and petrol usage were all assumed to scale linearly with coal production. The assumption of linearity is based on PDP's understanding of the similarity of the continued mining activities to historical operations.

The same approach has been used to pro-rate in-pit electricity usage for each Project sub-area. Electricity usage at the CHPP was calculated separately to in-pit electricity usage but was also assumed to scale linearly with coal production and was therefore attributed to coal production within each sub-area. Ngakawau electricity usage is included in CHPP electricity usage.

Predicted explosive (ANFO) usage was supplied for the MFS, ESE and Stockton Project sub-areas.

Emissions associated with the on-site wastewater systems were based on the Full Time Equivalent (FTE) employee estimates for Stockton, MFE and ESE. The data provided by Bathurst accounted for all internal and external/contracted workers, respective shift hours, machine hours and contingencies, such as day visitors (refer to Appendix C). PDP has assumed that the staff numbers remain constant across the Project in the absence of future staff predictions. The MfE domestic wastewater emission factor for septic tanks was applied to the annual FTE to estimate carbon emissions.

Emissions for progressive rehabilitation (between FY28 and FY42) at the MFS and ESE Project sub-areas were based on diesel usage supplied by Bathurst. Emissions for progressive rehabilitation activities at Stockton were estimated based on the rehabilitation schedule and a diesel factor (3000 Litres of diesel/ha rehabilitated) supplied by Bathurst for all Project sub-areas. Emissions from diesel for rehabilitation activities post FY42 were estimated based on the estimated remaining rehabilitation areas and the same diesel factor.

Emissions from deforestation were estimated using the proposed stripping schedules (refer to Appendix C). All proposed deforestation areas were assumed to be covered in post-1989 regenerating natural forest (based on aerial imagery and historical disturbance areas). VDT (involving the preservation and relocation of existing vegetation) is currently practiced at Stockton and is considered in the estimation of deforestation and reforestation emissions. Vegetation involved in VDT was considered to be mature and therefore not contribute to net GHG removals. Emission removal via carbon sequestration associated with the growth of vegetation was based on the rehabilitation schedules provided by Bathurst (refer to Appendix C). All rehabilitated land was assumed to be replanted in indigenous vegetation with an age to maturity of at least 22 years (Ministry for the Environment, 2024).

4.0 Assessment of Impacts

Emissions across the Project are broken down into emissions arising from operations within each Project sub-area. Emission sources that could not be attributed to a particular Project sub-area are reported separately.

To summarise, the assessed Scope 1 and Scope 2 GHG emissions include the following sources:

- Fugitive coal seam emissions from coal production;
- Explosive use;
- Emissions from on-site wastewater treatment;
- Electricity usage to the end of mine life (separated into electricity usage in each pit, and usage for coal processing at the CHPP, which includes Ngakawau electricity usage);
- Diesel usage by the vehicle fleet within each pit;
- Heavy oil usage (as lubricant) to maintain the vehicle fleet in each pit;
- Petrol usage (for light vehicles) within each pit;
- Diesel usage for hauling of coal (along UWHR, and between the CHPP and the Aerial Ropeway);
- Diesel usage for rehabilitation activities at the Stockton, MFS, ESE and UWHR sub-areas;
- Diesel usage for other operations across all pits including pumping of stormwater and diesel used for generators;
- Emissions arising from LULUCF (deforestation) within the Project footprint;

- Negative emissions (carbon sequestration) arising from reforestation within the Project footprint; and
- Emissions from the relocation of mining equipment owned by Bathurst to the Buller Plateaux.

4.1 Stockton Emissions

PDP has estimated the total GHG emissions associated with operations at the Stockton sub-area, including the A-Drive Borrow Pit. Throughout the life of the Project, Scope 1 and 2 emissions from Stockton operations are predicted to total 74,826 t CO_2-e, accounting for 6% of total Project Scope 1 & 2 emissions not including LULUCF (deforestation and reforestation). Coal extraction from the Stockton Project sub-area is predicted to cease in FY37[27].

Table 6 shows a breakdown of the emission sources and Figure 6 shows this graphically. Emissions associated with rehabilitation and LULUCF are reported elsewhere as discussed below.

The largest contributor is vehicle fleet diesel usage (71%), followed by fugitive coal seam gas from surface coal production (20%). Within the Stockton sub-area, the ratio of emissions to coal production is 0.02 t CO_2-e/t coal, excluding LULUCF.

LULUCF emissions for the Stockton Project sub-area are reported separately in Section 4.6 to account for carbon sinks from reforestation. Emissions from diesel use for rehabilitation are also reported separately in Section 4.5.2.

[27] Note that electricity consumption for coal processing activities is pro-rated based off the coal production of individual pits, and therefore the contribution for each pit is estimated in the applicable section. Electricity consumption is therefore estimated for all years that coal is produced across the Project.

[redacted]

[28] For example, the WWTP operation.

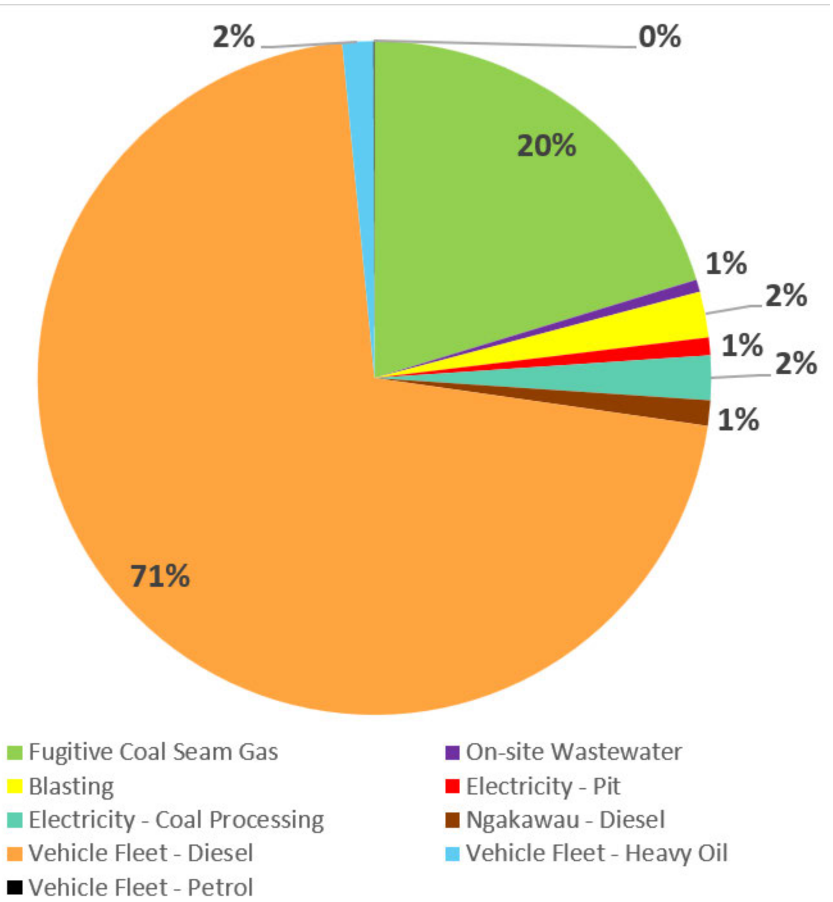

Figure 6: Breakdown of Scope 1 and 2 GHG Emissions from Stockton Operations Excluding LULUCF and Rehabilitation Activities

4.2 Mt Fredericks South Emissions

The MFS Project sub-area is estimated to produce 145,536 t CO_2-e across the life of the Project, contributing 12% of total Project Scope 1 and 2 emissions (excluding LULUCF). Table 7 shows a breakdown of the emission sources and Figure 7 shows this graphically.

The most significant contributions are from vehicle fleet usage of diesel (72% of MFS operations), fugitive coal seam gas (15%) and limestone usage for waste rock neutralisation (6%). All other emissions contribute 2% or less to total MFS operational emissions. Emissions from diesel use for rehabilitation are presented separately in Section 4.5.2.

Staffing numbers for MFS are included in staffing estimates for the ESE Project sub-area, therefore emissions from wastewater are accounted for in Section 4.3. LULUCF emissions are presented in Section 4.6. The ratio of emissions to coal production within the MFS sub-area is 0.04 t CO_2-e/t coal.

[redacted]

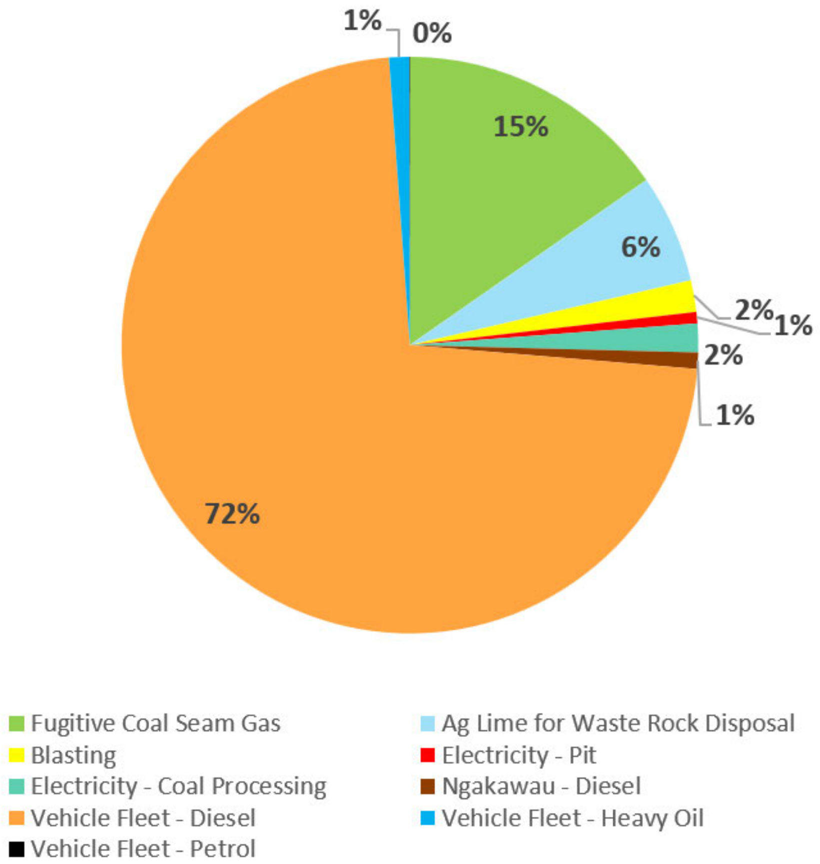

Figure 7: Breakdown of Scope 1 and 2 GHG Emissions from MFS Operations Excluding Rehabilitation Activities

4.3 Escarpment Extended Emissions

The ESE Project sub-area is estimated to produce 791,222 t CO_2-e across the life of the Project, contributing 63% of total Project Scope 1 and 2 emissions (excluding LULUCF). Table 8 shows a breakdown of the emission sources and Figure 8 shows this graphically.

Vehicle fleet diesel usage is 75% of ESE emissions, 13% are from limestone usage for waste rock neutralisation, and 8% are fugitive coal seam gas from surface coal production.

[redacted]

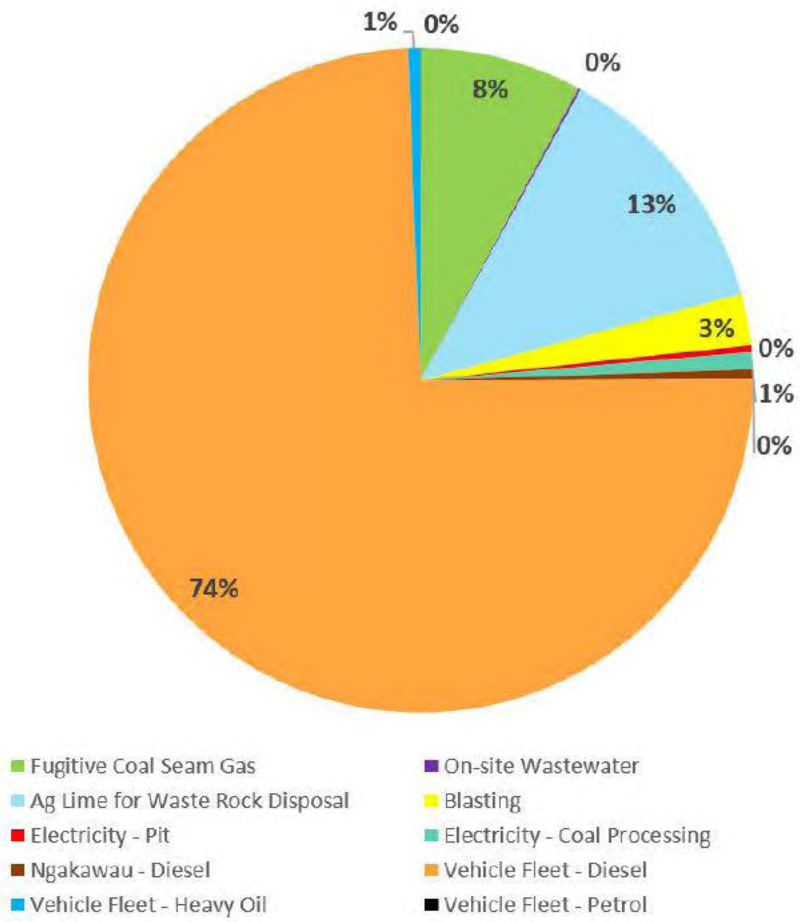

Figure 8: Breakdown of Scope 1 and 2 GHG Emissions at the ESE Project sub-area Excluding Rehabilitation Activities

The ratio of emissions to coal production at ESE is 0.08 t CO_2-e/t coal, higher than Stockton and MFS, due to the diesel usage from the higher strip ratio[29] at ESE as presented in Table 9.

Table 9: Strip Ratio for Project Sub-Areas (Bathurst Resources Limited, 2025)

Project Sub-Area	Strip Ratio (bcm/tonne)
Stockton	5
MFS	4
ESE	12

[29] The ratio of overburden (waste rock) which must be stripped per tonne of coal produced.

4.4 Upper Waimangaroa Haul Road Emissions

4.4.1 Emissions from UWHR Construction and Maintenance

Emissions associated with the construction of the UWHR are excluded from this assessment, as mentioned in Section 3.5. Emissions arising from aggregate production (which are Scope 1) are captured in emissions from fuel use at Stockton (A Drive Borrow Pit) assessment.

Operational emissions for the UWHR, which are assessed, are therefore limited to diesel used for road maintenance.

4.4.2 Emissions from Coal Haul

Emissions associated with coal haul along the UWHR are not captured by in-pit estimations of diesel usage. Rather, Bathurst provided the projected diesel usage associated with coal haul, which has been assessed separately. Coal haul from each pit to the CHPP and coal haul from the CHPP to the start of the Aerial Ropeway along a 7.4 km haul road is understood to be included in this estimate.

4.4.3 Summary

Table 10 summarises the estimated Scope 1 and 2 emissions associated with maintenance and coal haul along the UWHR, which total 62,593 t CO_2-e. The UWHR sub-area contributes 5% of total Project Scope 1 and 2 emissions (excluding LULUCF).

[redacted]

4.5 Other Emissions

4.5.1 Emissions from Support Operations

Bathurst provided diesel usage for support operations not associated with any particular Project sub-area. Support operations include diesel used for generators, pit pumping, the ANFO delivery vehicle, light vehicles, operator buses and operator vans.

New equipment is not proposed to be purchased and as a result embodied carbon emissions have not been calculated. Any additional vehicles required for the expanded mining operations under the Project will be sourced from mining operations owned by Bathurst or its subsidiary companies. These operations include Rotowaro Mine and Maramarua Mine in the North Island, and Takitimu Mine in the South Island.

4.5.2 Emissions from Rehabilitation Diesel Use

GHG emissions from diesel use associated with rehabilitation activities include land reshaping, capping, topsoil distribution and planting.

These estimated emissions across all Project sub-areas include progressive rehabilitation occurring between FY28 and FY42; and post-coal-winning rehabilitation between FY43 and FY52 (including rehabilitation of the UWHR). Rehabilitation of historical Stockton mining areas is included because these operations occur within land owned by the applicant and within the Project timeframe.

4.5.3 Summary of Other Emissions

Table 11 presents the GHG emissions from support operations, relocation of mining equipment and rehabilitation diesel usage. These emissions total 157,009 t CO_2-e, contributing 13% of total Scope 1 and 2 emissions (excluding LULUCF) across the Project.

[redacted]

4.6 Emissions from LULUCF

Table 12 presents LULUCF emissions and removals across the Project. Deforestation emissions were estimated based on the total stripped footprint less all areas of VDT. Reforestation emissions were estimated based on the total cumulative rehabilitated footprint less all areas of VDT.

[redacted]

Deforestation is estimated to be 97,170 t CO_2-e across the life of the Project. Emission removals or carbon sequestration from forest replanted in all rehabilitated areas is estimated to be 159,262 t CO_2-e across the life of the Project. PDP has assumed that all vegetation planted throughout the Project's duration will continue to sequester carbon annually. This assumption is based on the average age at which vegetation matures and no longer continues to sequester carbon being 22 years (Ministry for the Environment, 2024). The actual sequestration rate will vary depending on the type of vegetation planted.

[30] Note that carbon sequestration from reforestation is calculated per year and is cumulative across the growth stage of the vegetation (approximately 22 years from planting).

Because revegetation removes carbon from the atmosphere, it is assessed as a negative emission. Net GHG emissions from LULUCF activities across the Project total -62,092 t CO_2-e. This is equivalent to the removal of 5% of total Scope 1 and 2 Project emissions.

4.7 Summary of Embodied Carbon Emissions

Embodied carbon emissions can arise from following sources:

- Construction of new infrastructure and facilities;
- Construction of the UWHR and other haul/access roads;
- Relocation of machinery owned by Bathurst; and
- Purchase of new equipment or machinery.

Contractors will construct new infrastructure and facilities and are excluded from this assessment, as mentioned in 3.5.

The UWHR will be constructed with aggregate from the A Drive Borrow Pit. The Scope 1 emissions associated with the raw material supply stage (the aggregate production) have been accounted for in Section 4.1 and 4.4. Embodied carbon associated with the transport of aggregate from the borrow pit to the new access roads and UWHR is accounted for in Section 4.1 and 4.4. Diesel usage for maintenance is captured under Section 4.5.

Where possible, existing equipment from Stockton Mine, Rotowaro Mine or Takitimu Mine will be utilised for the Project. The fuel usage associated with hauling machinery from Rotowaro Mine or Takitimu Mine has been estimated in Section 4.7. Where existing equipment is not available, contractor equipment will be sourced (Scope 3), and a limited number of new vehicles may also be required. It is unknown where this new machinery will be sourced from and how it will be transported to site, therefore any emissions from this activity have not been included.

4.8 Summary of Emissions Across the Project

Table 13 presents the breakdown of the estimated Scope 1 and Scope 2 emissions for the Project. This breakdown is presented graphically in Figure 9 (excluding LULUCF). The estimated Scope 1 and Scope 2 emissions total 1,231,185 t CO_2-e across the lifetime of the Project (excluding LULUCF). When considering LULUCF activities, the net Scope 1 and 2 emissions across the life of the Project total 1,169,093 t CO_2-e, equivalent to a 5% decrease.

The largest contributor to emissions is from in-pit vehicle fleet diesel usage at 62% of total emissions excluding LULUCF. Diesel from support operations, limestone application to waste rock disposal, and fugitive coal seam gas emissions from surface coal production are 10%, 9%, and 8% of total emissions excluding LULUCF respectively.

[redacted]

[redacted]

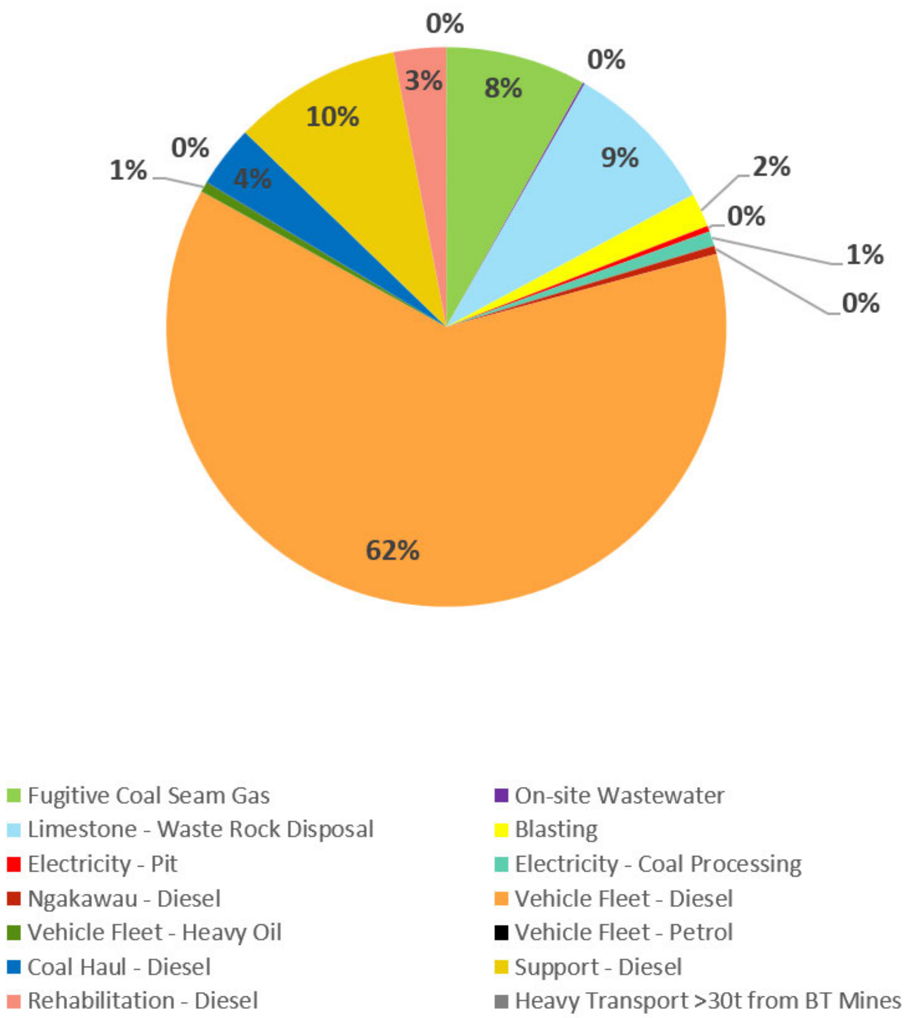

Figure 9: Breakdown of Total Estimated Scope 1 and 2 GHG Emissions Across the Project Excluding LULUCF Activities

[redacted]

Figure 11 presents an annual breakdown of the estimated Scope 1 and 2 GHG emissions, overlaid with projected coal production. As expected, GHG emissions are generally proportional to coal production because many emissions have been estimated based on a pro-rate of coal production.

[redacted]

Figure 12 summarises the sources of GHG emissions across the Project. Diesel use results in the greatest contribution towards GHG emissions, which is 80% of total Scope 1 and 2 emissions excluding LULUCF. Limestone reacting with PAF waste rock contributes 9% of total emissions, and fugitive coal seam emissions contribute 8% of emissions, with remaining sources contributing 2% or less. The most effective way for Bathurst to reduce GHG emissions from Project operations is by reducing diesel consumption, potentially by considering electrification where practicable

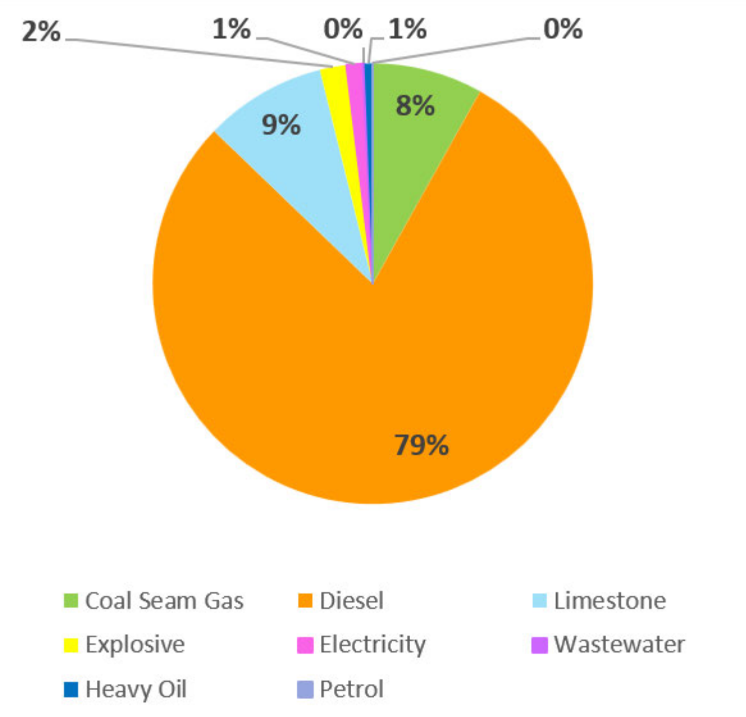

Figure 12: Simplified Breakdown of Scope 1 and 2 GHG Emission Sources from the Project (Excluding LULUCF)

A further breakdown of fuel use by vehicle type is presented in Figure 13[31]. Note that “ADT” refers to Articulated Dump Trucks. The ‘Miscellaneous” category consists primarily of ancillary vehicles (such as water carts, graders, operator transport vehicles and other light vehicles) and other diesel-consuming machinery including drills, generators and pit pumps. Electrification may become practical during the life of the Project and has the potential to reduce Scope 1 and 2 as reported in this assessment.

[31] Diesel use for rehabilitation at Stockton, equipment relocation, and in-pit diesel usage at Stockton and Ngakawau is not included in this breakdown.

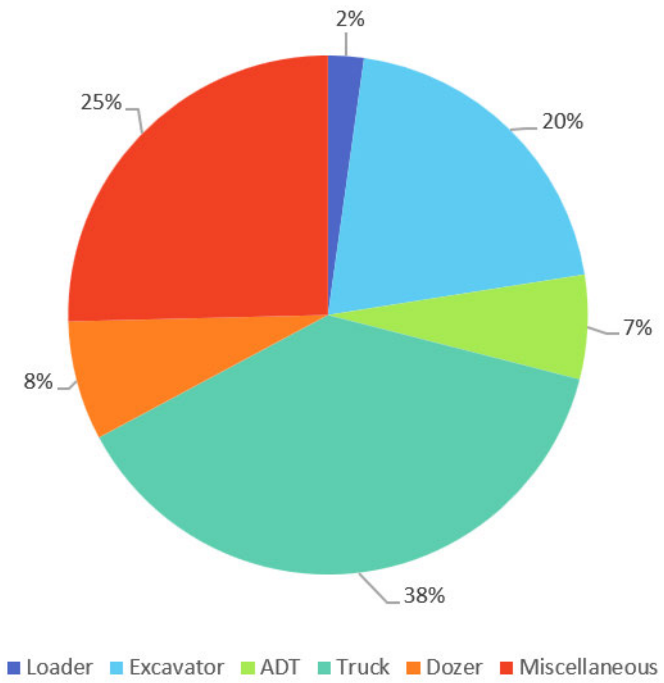

Figure 13: Breakdown of Diesel Usage by Vehicle Type across the Project

5.0 Emission Reduction Opportunities

Bathurst's annual report considers the opportunities to reduce emissions throughout its operations (Bathurst Resources Limited, 2024).

This assessment has estimated the emissions associated with the Project and can therefore be used to inform Bathurst's strategy for emissions reductions. Based on Bathurst's annual report, opportunities that are relevant for reducing emissions associated with this project include:

- Electrification of the fleet where practicable, especially support vehicles such as the operator van and other light vehicles;
- Using biofuels as a substitute for diesel where practicable and where electrification is not suitable;
- Investing in lower emission and more efficient equipment when existing equipment is due to be replaced; or when new equipment is required that cannot be sourced from within the applicant's wider fleet;
- Avoiding embodied carbon emissions and delaying end-of life emissions by continuing to use existing infrastructure, equipment and facilities where possible;
- Maintaining vehicles and equipment in line with good practice to optimise fuel efficiency;
- Backfilling with material produced during mining operations, which minimises emissions from carting waste rock offsite and importing fill materials; and
- Investigating reduction and mitigation strategies for fugitive coal seam emissions.

Bathurst has developed a Project-specific strategy to address the estimated emissions from the Project, the Sustainability, Energy Use and Greenhouse Gas Emissions – Buller Plateaux Continuation Project (Bathurst Resources Limited, 2025). This assessment has not specifically accounted for initiatives that may be implemented in the future operation of the Project.

6.0 Conclusion

Bathurst is proposing to extract approximately 16 million tonnes of coal from the Project sub-areas across a 25-year period beginning in April 2027.

This report has estimated the Scope 1 and Scope 2 GHG emissions from the extended coal mining activities. The estimated emissions impact, resulting in an increase of GHG emissions, is around 1,243,000 t CO_2-e across the life of the Project excluding LULUCF. Most GHG emissions are attributed to diesel usage by the vehicle fleet for each sub-area, limestone applied to waste rock and fugitive coal seam emissions from surface coal production at 80%, 9% and 8% of total emissions respectively, excluding LULUCF.

With deforestation and reforestation considered, the project has a net *negative* emissions impact of 1,169,089 t CO_2-e estimated across the life of the Project. Under the NZ ETS, Bathurst is required to surrender NZUs for diesel, petrol and fugitive coal seam emissions from coal mining activities, which will continue based on the actual annual emissions quantified via corporate reporting. This assessment provides projected emissions over the life of the Project and is therefore separate to Bathurst's reporting obligations under the NZ ETS.

GHG emissions from construction of facilities and infrastructure by contractors are excluded from this assessment. If these emissions were included, they would likely have a material influence on the predicted carbon footprint for the Project.

Emissions reductions opportunities across the Project include reduction of fleet diesel usage where possible, such as via electrification of support vehicles or use of biofuels and investment in lower emissions equipment when new equipment is required. Bathurst is separately considering implementation of reduction opportunities.

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Appendix A: Technical Mining Report Subsidised by Bathurst

New Zealand West Coast Coal and Mining Operations

A Technical Reference

BATHURST RESOURCES LIMITED

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Glossary of Terms

3D	Three Dimensional
AMD	Acid Mine Drainage
ANC	Acid Neutralisation Capacity
ARD	Acid rock drainage
ACIRL	ACIRL Quality Testing Services Pty Ltd
ASTM	American Society for Testing and Materials
bcm	Bank cubic metres
BPCP	Buller Plateaux Continuation Project
^oC	Degrees Celcius
CFSF	Coal Fines Storage Facility
CPP	Coal Handling Processing Plant
CO_2	Carbon Dioxide
CPP	Coal Processing Plant
CSN	Coal swell number
DMC	dense media cyclones circuit
DOC	Department of Conservation
EAF	Electric Arc Furnaces
ELF	Engineered Landform
ESE	Escarpment Extension
GDP	Gross Domestic Product
H_2	hydrogen
HCC	Hard coking coal
HAF	High Acid Forming
IEA	International Energy Agency
ISO	International Organization for Standardization
JORC	The Australasian Code of Reporting of Exploration Results, Mineral Resources and Ore Reserves
KPI	Key Performance Indicator
kg	Kilograms
LOMP	Life of Mine Plan
MPA	Maximum Potential Acidity (MPA)
MFS	Mt Fred South
MSR	Mussel Shell Reactor
NAF	Non-Acid Forming
NATA	National Association of Testing Authorities
NAPP	Net Acid Production Potential
NPV	Net Present Value
NZ	New Zealand
PAF	Potential Acid Forming
PHCC	Premium Hard Coking Coal
PCI	Pulverised coal for injection
PHCC	Premium hard coking coal

PVC	Polyvinyl chloride
Ro(max)	Maximum Reflectance of Vitrinite
ROM	Run of Mine
SSCC	Semi soft coking coal
SHCC	Semi-hard coking coal
SDS	Sustainable Development Scenario
TWh	Terra Watt hours
USGS	United States Geological Survey
VDT	Vegetation Direct Transfer
WWHCC	Whareatea West HCC premium product

Definitions

Aromatic Carbon	Aromatic carbon is carbon found in stable, ring-shaped molecular structures (aromatic rings), and is an important indicator of coal maturity and quality in geological and mining contexts.
Aliphatic Carbon	Aliphatic carbon is found in the molecular structure of coal, especially in lower-rank coals (such as lignite and sub-bituminous), where the proportion of aliphatic carbon is higher. The presence of aliphatic carbon affects the chemical reactivity, calorific value, and coking properties of coal.
Ash	Refers to the non-combustible mineral matter remaining after the coal has been burned
Beneficiation	A process used in the mining industry to upgrade the quality of the run of mine (or raw) coal or ore by separating out the material that degrades the overall product. The goal of the ***beneficiation*** process is to improve the economic value of the coal or ore by increasing the concentration of the desired component.
Blast Furnace	A large, vertical, tower-like smelting furnace used primarily for the extraction of metals—most notably iron—from their ores. It operates by introducing a blast of hot, compressed air from below, which enables rapid combustion and high temperatures necessary for smelting.
Carburising agent	Material used in steelmaking process that introduces carbon into iron or steel. This process increases carbon content of the metal which improves its hardness and other mechanical properties.
Calorific value	Refers to the amount of energy released when a specific amount of coal is completely burned.
Coalification	The transformation of peat into coal. The coalification process concentrates the carbon content and transforms peat into lignite (stage 1), then sub-bituminous coal (stage 2), then bituminous coal (stage 3) and then anthracite (stage 4). Lignite has the lowest carbon concentration and anthracite has the highest carbon concentration.
Coal type	Directly relates to the types of vegetation that formed the peat in the first instance and the conditions under which the coal was buried and transformed over millions of years
Coal rank	Classifies coal based on the coalification stage of the rock

Coke	Is a solid reductant made by heating bituminous coal (a special type of coal) in the absence of air to produce a hard porous material that is nearly pure carbon. Coke is an essential ingredient for steel production
Core coal seam	A cylindrical sample of coal and surrounding rock that is extracted intact from the ground.
Engineered Landform (ELF)	An Engineered Landform is a term used to describe the final landform which has been designed and constructed to be free draining and long term stable, chemically and geotechnically
Feasibility Study	A comprehensive, detailed evaluation of a proposed mining project to determine whether the resource can be mined economically within regulatory requirements.
Pre-Feasibility Study	An early-stage evaluation of a project's potential. It aims to determine whether the project is viable to justify progressing more detailed investigations and support regulatory applications.
Fixed carbon	A measure of the amount of non-volatile carbon remaining once volatile matter and moisture have been driven off during heating
Fluidity	A key property that measures how easily coal transforms into a viscous, molten, plastic state when heated; crucial for its use in making coke
Inherent moisture	The water within the microscopic structure of the coal, generally filling the pores.
JORC Code	Provides a mandatory reporting system for the classification of minerals Exploration Results, Mineral Resources and Ore Reserves according to the levels of confidence in geological knowledge and technical and economic considerations.
Lithologies	Refers to the physical and chemical characteristics of rocks including their mineral composition, grain size, texture and colour. In mining and geology, lithologies describe the different types of rock units encountered in a deposit or formation. Examples include sandstone, mudstone, conglomerate, coal and claystones.
Metamorphic processes	transforms existing rocks into new ones through heat, pressure, and chemical reactions, without melting them. This occurs deep within the Earth or at tectonic plate boundaries.
Mine subsidence	Any underground excavation will lead to a response from the overlying overburden strata (or rock). This response is called "**mine subsidence**" and it consists of downward deformation of the strata towards the underground excavation due to gravity and may involve a degree of overburden dislocation and/or rock failure
Orthophoto	an aerial image that has been geometrically corrected to remove distortions such that it creates a "map like" image which makes it possible to use the image for accurate measurements of distance, for example, and direct overlaying with other map data
Peneplain	A **peneplain** is a broad, nearly level land surface produced by long-term erosion and weathering, which reduces the landscape to a gently undulating plain with minimal relief. It represents the final stage of fluvial erosion during which the land is worn down almost to base level, leaving only isolated hills or residuals.

RoMAX	A measure of the maximum reflectance of vitrinite used as an indicator of relative rank
Rotary breaker	A large industrial machine that is used for crushing and sizing coal and/or rock, and can separate some waste material from the usable product. It consists of a large rotating cylinder that effectively breaks the rock into smaller pieces and separating softer coal from harder stone/rock.
Sankey Diagram	A tool used to represent the blending of coals from various mining pits and the spread of products that meet customers specifications.
Sedimentary Rock	Rock that forms from the accumulation and compaction of mineral and organic particle, such as sand, mud or plant material often in layers. Over time, these materials are buried and harden into rock through pressure and chemical processes.
Stockpile Stacking	The process of piling coal of a similar quality or specification into large mounds for storage, using machines called stackers. Various proportions of the stacked coal can be blended to achieve an overall coal quality required by a customer.
Sulphur	An undesirable coal constituent and its presence stems from the environment within which the coal was formed.
Vitrinite	The primary reactive component in carbonisation that acts as a binding agent enabling the creation of coke. Vitrinite is formed from altered remains of the woody parts of plant material that formed the peat
Volatile matter	A measure of the non-water gases formed and released from heating and burning coal.

Executive Summary

Background

Coal is a diverse geological material with significant variation in how it forms, what it contains and how it can be used. Some types—such as the rare coals of New Zealand's (**NZ**) West Coast—are especially valuable. This document focuses on the unique coals of the Buller Plateaux Continuation Project (**BPCP**), the mining methods used to extract them and the technical terminology needed to understand their properties. The purpose of this document is to help readers better appreciate the science, value and specific uses of coal proposed to be extracted from the BPCP.

All Coal is not created Equal

Vegetation types that formed NZs West Coast coal is approximately 200 - 170 million years younger than typical Australian coal types. The processes that formed the coal were a lot faster, being driven by geological disturbance, plate tectonics, squeezing and folding, rather than the peat being buried and squeezed over time.

The majority of the coal from BPCP will be used to make coke for iron making. Blast furnace iron making is still the dominant method of making steel (Iron becomes steel when carbon is added and the impurities are removed, making it stronger and more versatile), particularly in developing economies such as India. Whilst steel can be recycled, there is simply not enough steel available to recycle in a developing economy to meet demand. The production of "green steel" is in its infancy and whilst promising, it is facing significant challenges. Therefore, for the foreseeable future (that is the next 20-30 years as a minimum), the manufacture of steel using coal and coke will continue and Buller Plateaux coal will continue to be in high demand.

A suite of Technical Expertise

Coal resources are identified and assessed through a long exploration phase involving drilling, mapping, sampling, analysis and advanced geological modelling. Once the geology is understood, mining engineers—together with environmental specialists—design the most efficient extraction and rehabilitation plans, turning geological models into mining models. Coal processing experts then evaluate coal quality to determine processing and blending requirements, while civil engineers design the necessary supporting infrastructure. Alongside this, complex mine planning incorporates selective overburden (the material above the coal seam) removal and placement, water treatment and management, coal extraction and rehabilitation requirements.

The variety of coals available from the multiple pits proposed for the BPCP is critical to consistently meet customer blend specifications, highlighting the highly skilled, multidisciplinary nature of the entire operation. This document aims to explain the scientific, technical and highly coordinated processes and technical expertise required to find, extract, process and blend coal to meet customer specifications.

Buller Plateaux Coal – a rare commodity

The coal from the Buller Plateaux has unique properties and for this reason, the coal products and blends are highly sought after by steel manufacturers around the world. As a result of its special qualities, high carbon content and high energy rating, less coal is needed to produce a tonne of steel. Flowing on from these benefits comes reductions in greenhouse gas emissions and significant cost savings for steel producers.

The BPCP is a nationally and regionally significant project

The economic benefits from the BPCP are nationally and regionally significant [redacted]

[redacted]

1 Introduction

Modern civilisation was built on the Industrial Age, which relied heavily on the use of natural fuels and metals. Without these natural resources, there would be no cars, rapid air travel or even many of today's renewable energy technologies. Most importantly, the current standard of living in New Zealand (**NZ**) would not be possible without the widespread use of these natural materials.

Natural fuels come in different forms, and one of the more common fuels consumed today is coal. Coal is not just a rock that can be burnt, there are different coal types that are used for very different purposes. Coal is a complex geologic material varying widely in its formation processes, its constituents and its uses. There are some coals that are quite rare and are highly prized such as NZ's West Coast coals.

The purpose of this document is to introduce the science behind different types and grades of coal focussing on those associated with the Buller Plateaux Continuation Project (**BPCP**) which are predominantly used for industrial steel making. This document will also define some of the more technical terms so that the reader can be more fully informed to understand the science behind, the value of and use of coal, specifically, the coal from the BPCP.

2 Coal – a Complex Geological Material

2.1 What is coal?

Coal is a sedimentary rock[1] comprised of predominantly carbon that is combustible, meaning that it is formed by the accumulation in a peat bog with little sedimentary input, with subsequent burial and alteration transforming it to coal. It is geologically unusual for peat to accumulate and then to be preserved to be transformed into coal.

Coal is used in a number of ways, for electrical generation or if the coal is a particular ***rank*** **(Section 2.3.1)** and ***type*** **(Section 2.3.2)**, it can be transformed into ***coke*** (**Section 2.5**), an essential ingredient for making iron and refining into steel[2] (**Section 3**). In addition to its use as a fuel, coal is a raw material from which nylon and many other plastics as well as organic chemicals can be made for use in dyes, fertilisers and clothes.

Coal tells a story unlike most sedimentary rocks. Instead of being eroded and carried far from its source, coal is formed right where lush plants once thrived millions of years ago. Those plants fell into ancient swamps, where oxygen-starved waters created the perfect setting for transformation. In these stagnant pools, oxygen was very low, and anaerobic bacteria went to work, breaking down plant matter and concentrating carbon. Over time, the microbes turned this material into peat—until acids from decaying plants wiped them out, leaving behind the raw ingredients for coal

KEY TAKEAWAY

Coal is a special type of rock that is combustible. There a different coal ranks and types that are not all the same. Coal is located only where it was laid down, so is confined to only certain locations.

[1] Sedimentary rock – Rock that forms from the accumulation and compaction of mineral and organic particle, such as sand, mud or plant material often in layers. Over time, these materials are buried and harden into rock through pressure and chemical processes.

[2] Skinner, B.J. and Porter, S.C. (1987). Physical Geology.

2.2 What is coalification?

Coalification is the transformation of peat into coal. Under geologically usual circumstances, peat is formed, then buried by other sediments in a subsiding basin. In response to burial and increase in temperature and pressure leads to chemical and physical changes in the peat. Although coalification is a continuum, the degree of coalification is termed "rank" Rank classifications within the ***coalification process*** include ***lignite*** (stage 1), then ***sub-bituminous coal*** (stage 2) then ***bituminous coal*** (stage 3) then ***anthracite*** (stage 4). Importantly, the coalification process is not just associated with physical compressional changes; there are also significant chemical changes that occur at that same time[3].

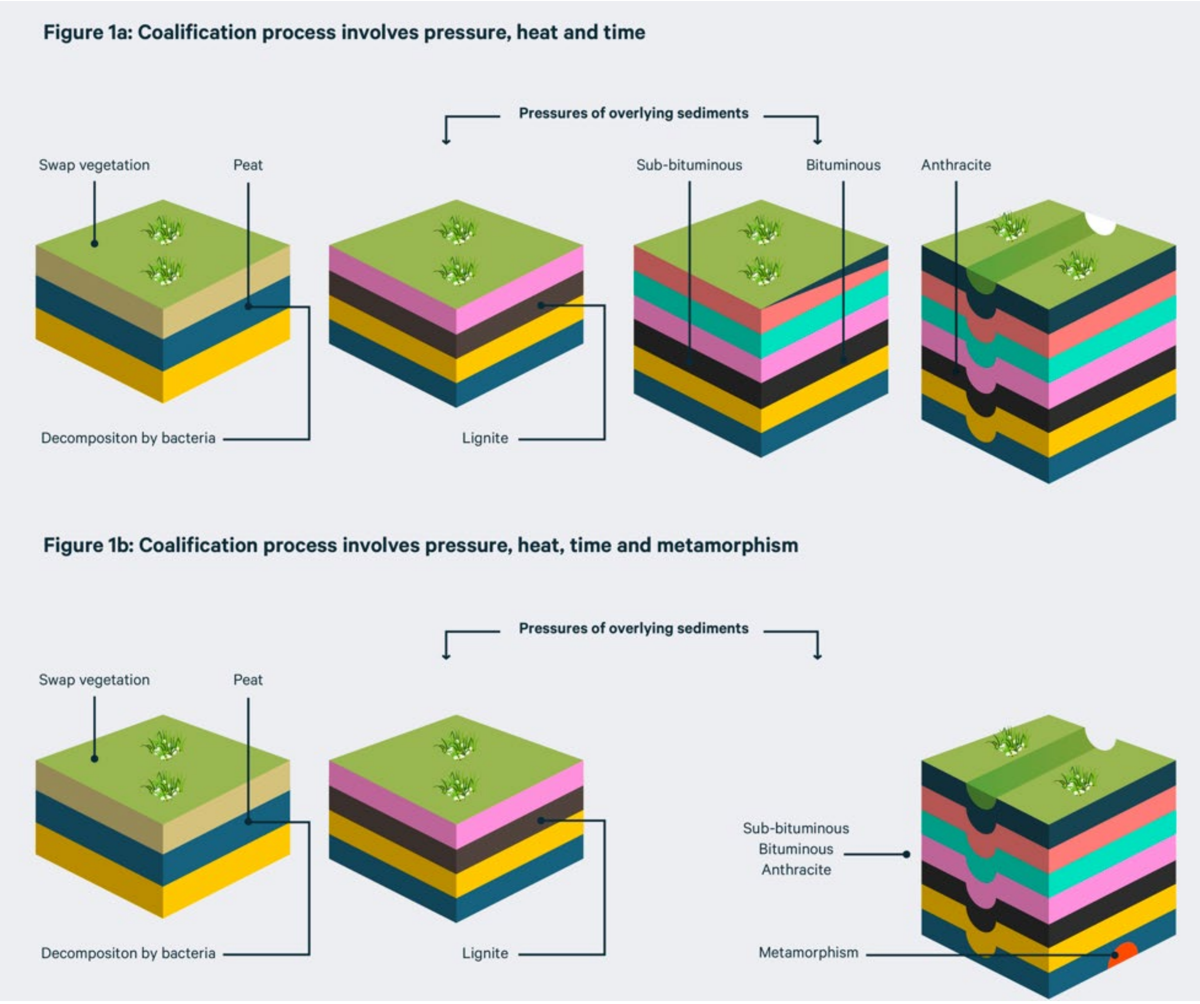

Figure 1a/b: Coalification process involves pressure, heat and time

The transformation of peat into coal can occur in a tectonically active environment where burial and uplift may be geologically "fast" or the nearby intrusion of volcanic materials (i.e. igneous dykes)[3].

Most of the world's coals were formed around 200-350 million years ago where vegetation was dominated by giant club mosses, tree ferns, horsetails and the earliest examples of seed-bearing plants such as conifers and seed ferns[4]. By comparison, Australian coal resources were formed approximately 299 – 145 million years ago.

[3] Skinner, B.J. and Porter, S.C. (1987). Physical Geology
[4] www.bgs.ac.uk

NZ's West Coast coals were formed around 35 (Brunner coal measures) to 60 (Paparoa Coal Measures) million years ago, from more evolved vegetation types containing flowering plants[5]. The West Coast Paparoa coal measures were established within narrow, elongate, fault basins known as the Paparoa Trough[6]. The Brunner coal measures accumulated on a peneplain. Accumulation of the Brunner coal measures was followed by a marine incursion (inundation of land by ocean waters caused by sea level rise), approximately 34 million years ago to 23 million years ago. This resulted in up to 2,500 metres of marine sediments being deposited into the trough over the coal bearing sediments, which were later uplifted by a major change of tectonic activity – a process termed ***inversion tectonics***. Consequently, the peat material underwent a quick coalification process caused by plate tectonic activity resulting in a young bituminous coal rank at high altitudes. Another important aspect of NZ West Coast coal is that the original vegetation forming the peat was very different to other coal materials across the world with some very unusual properties, giving them high value for specialised purposes[7].

KEY TAKEAWAY

The vegetation that formed NZ's West Coast coal is approximately 275 million years younger than the majority of the worlds coal deposits and approximately 200 – 170 million years younger than Australian coals. Not only is NZ's coal a lot younger, the coalification process was a lot faster, being driven and metamorphosed by geological disturbance, plate tectonics, squeezing and folding, rather than by peat being buried and squeezed for c. 200 million years as is the case for other coals around the world. The estuarine environment within which NZ's West Coast coal was created has also resulted in the development of special properties within the coal. The coal found within the Buller Plateaux, is a very special commodity as a result of its situational and formation processes.

There are four stages of the coalification process, the transformation of peat into coal, being "lignite", "sub-bituminous", "bituminous" and änthracite" which defines the "rank" of the coal. Each stage concentrates the carbon content and modifies chemical and physical properties. As a result, each coal stage (or rank) is suitable for different uses.

2.3 Coal Rank and Types – Lignite to Anthracite

2.3.1 Coal Rank

Four main rank classifications (see Figure 2) are defined by the United States Geological Survey[8] as follows:

- **Lignite**: or brown coal, is the lowest grade of coal with the least concentration of carbon. Lignite has a low heating value and a high moisture content and is mainly used in electricity generation.
- **Sub-bituminous** : is black in colour and is mainly dull (not shiny), Sub-bituminous coal has low to moderate heating values and is mainly used in electricity generation
- **Bituminous**: is between sub-bituminous and anthracite. Bituminous coal usually has a high heating value and is used in electricity generation and steel making. It is blocky and appears

[5] www.teara.govt.nz
[6] www.solidenergy.co.nz
[7] www.teara.govt.nz
[8] www.usgs.gov

shiny and smooth, and has thin alternating shiny and dull layers. Bituminous coal has different grades as further discussed in **Section 2.5**.

- **Anthracite**: is the highest rank of coal. It is hard, brittle and black lustrous, often referred to as hard coal, containing a high percentage of fixed carbon and a low percentage of volatile matter. Typically, anthracite contains 86-98% carbon, producing more heat per weight unit and it burns cleaner due to its high carbon content and low impurity levels.

Figure 2: Coal Types or Coal Rank[9]

Rank stages are a system imposed on a continuum, with changes including:

- A decrease in air dried moisture
- An increased proportion of carbon with increased aromaticity (more aromatic carbon versus aliphatic carbon structures)
- Decreasing oxygen and then hydrogen concentrations
- Increasing calorific value (due to increased proportion of carbon)
- Development and then loss of thermoplastic properties

Figure 3 summarises the four coal ranks, relative energy and moisture properties as well as their preferred uses ("**thermal coal**" or "**metallurgical coal**") driven by the chemical changes in the coal.

[9] https://history.alberta.ca/energyheritage/coal/early-coal-history-to-1900/global-coal-formation/coal-properties.aspx#page-2

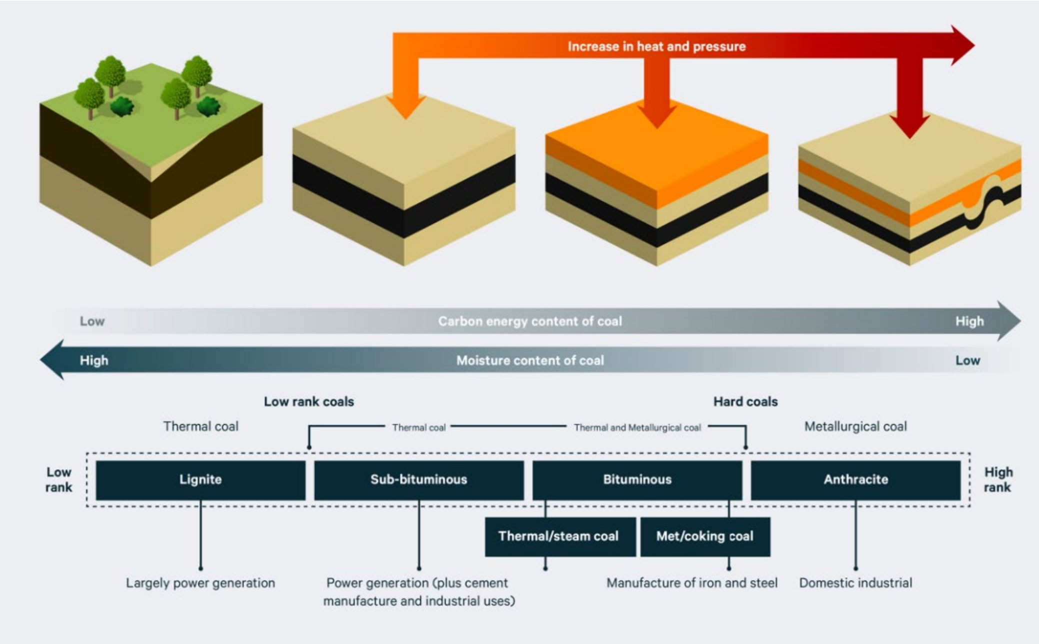

Figure 3: Coal rank and classification[10]

2.3.2 Coal Type

Coal "***type***" is directly related to the types of vegetation that formed the peat in the first instance and the conditions under which the coal was buried and transformed over millions of years. For example, different types of plants, such as woody vegetation versus algae, spores, flowering plants, lead to distinct types of coal with very different properties[11].

On the microscopic level, coal is made up of organic particles called macerals. Macerals are the altered remains and byproducts of the original plant material that formed the peat. Macerals are to coal as sediment grains and cements are to sedimentary rocks (i.e.. Sandstone) and are formed from different plant parts or different residues of bacterially, chemically or physically broken-down plant parts[12].

Coal petrographers (people who study coal under a microscope) separate macerals into three groups, each of which includes several maceral types. The groups are ***inertinite***, ***liptinite***, and ***vitrinite*** (see **Figure 4**). These groups are defined according to their greyness in reflected light under a microscope. Liptinites are dark grey, vitrinites are medium to light grey, and inertinites are white[13].

[10] Coal Rank and classification (https://whitehavencoal.com.au/wp-content/uploads/2023/06/WHC-Coal-Quality-Presentation-for-analysts.pptx.pdf

[11] teara.govt.nz/en/coal-and-coal-mining/page-1

[12] www.uky.edu

[13] www.uky.edu

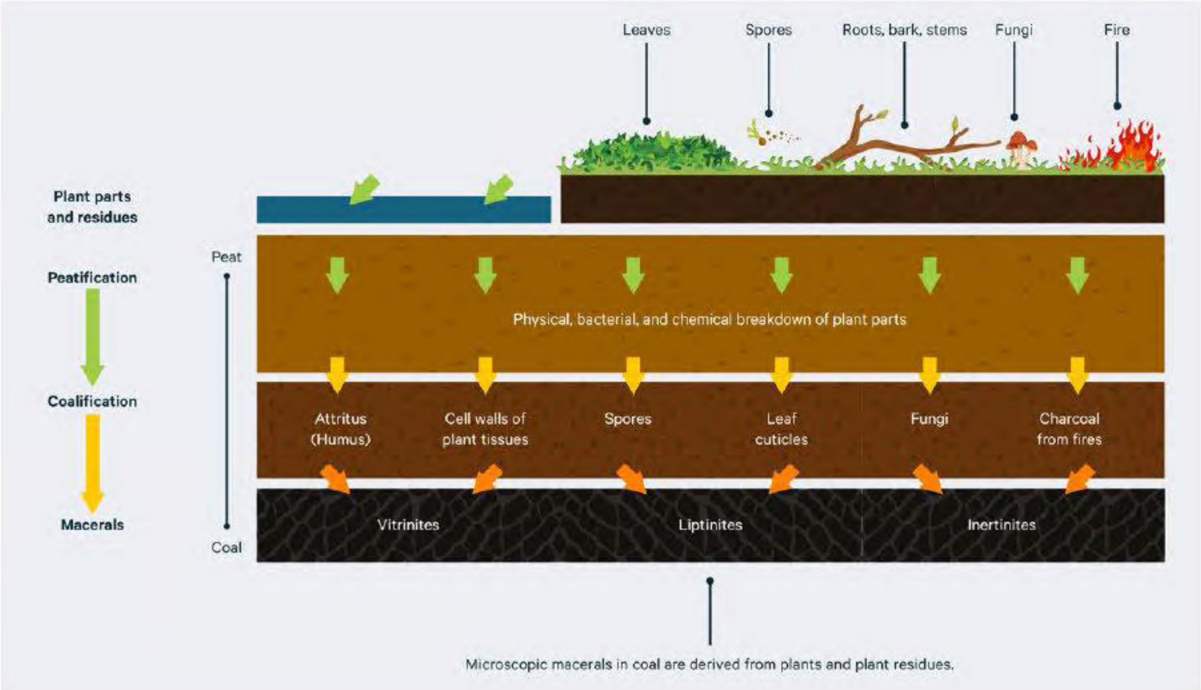

Figure 4: Development of coal[14]

Vitrinite is a very important component for steel making coal because it is the primary reactive component that acts as a binding agent enabling the creation of coke (see **Section** Error! Reference source not found.). Of relevance to metallurgical coal is the relative proportion of vitrinite. We can determine how much vitrinite is contained within coal by its vitrinite reflectance. Vitrinite reflectance is commonly used to infer coal rank and is useful as it reflects its technological properties. There are several types of vitrinite reflectance (**Ro**) measurements, the most important one being "RoMAX". RoMAX is the maximum vitrinite reflectance and is a most reliable measurement when assessing coal rank. Generally speaking, a high Ro means that the coal has a higher proportion of fixed carbon and energy value along with lower volatile matter and lower moisture – which are also necessary characteristics for coals used in the steel making process.

KEY TAKEAWAY

There are different ranks and types of coal. Most coals can contain vitrinite, however, the proportion of vitrinite varies widely. NZ's West Coast coals are characteristically higher in vitrinite (at > 86%) compared to other international equivalents such as Australia (55-65%). This makes NZ's West Coast coal highly sought after because Vitrinite-rich coal tends to have better coking properties making them valuable for industrial applications (i.e. metallurgical coal).

2.4 Important Coal quality parameters

Coal's chemical properties are crucial in steel making because they directly affect the quality and efficiency of the stell production process. Properties of interest for coal used in the steel making process can be divided into three categories, being **Chemical**, **Plastic** and **Petrographic**. Under each category there are several parameters that are crucial for steel manufactures to know before they

[14] Development of Coal (source: https://www.uky.edu/KGS/coal/coal-macerals.php)

purchase and utilise coal material. The remainder of this section defines some parameters of particular interest.

- Chemical properties[15].
    - Inherent moisture – refers to the water within the microscopic structure of the coal, generally filling the pores. Moisture absorbs heat, so high moisture content in coal reduces the relative efficiency of heating when a coal is combusted. Lower rank coals tend to have a higher moisture level. For steel manufacturing, a low moisture content is preferred because it improves efficiency in the steel plant, allows the coal to burn hotter. Lower moisture means less energy wasted on evaporating water, making the process more cost effective.
    - Ash – refers to the non-combustible mineral matter remaining after the coal has been burned. Ash content can vary widely from a low of 1% to as high as 55%. High ash coal reduces the calorific value of coal. In the steel industry, a low ash coal content is preferred and highly valuable. For steel manufacturing, a low ash content is preferred because it reduces impurities introduced into the steel.
    - Volatile matter – is a measure of the non-water gases formed and released from heating and burning coal. Volatile matter is directly related to coal rank; as rank increases, volatile matter content decreases. As volatile matter is driven from the coal material with increasing rank, the relative carbon percentage tends to increase and this is preferred for steel manufacturing because more carbon is available for iron production reduction reactions making the process more efficient and produces higher quality coke improving steel quality.
    - Sulphur – is an undesirable coal constituent and its presence stems from the environment within which the coal was formed. For example, coal with a high sulphur content is usually associated with marine influenced environments where sulphate rich sea water interacted with peat swamps. Coal with a sulphur content ranging between 3% - 6% is considered high. If steel making coal has too much sulphur it can increase sulphur content in the final steel product, leading to brittleness[16]
    - Fixed carbon – is a measure of the amount of non-volatile carbon remaining once volatile matter and moisture have been driven off during heating. Fixed carbon content increases with coal rank and is important for steel making because more carbon is available for reduction reactions making the process more efficient and producing higher quality coke improving steel quality.
- Plastic properties:
    - Fluidity – is a key property that measures how easily coal transforms into a viscous, molten, plastic state when heated; crucial for its use in making coke. It reflects the coal's ability to form a strong, coherent carbon structure. A higher fluidity typically indicates a greater ability to produce quality coke, influencing factors like particle bonding and pore structure[17]. Fluidity gives an indication as to whether a coal will bind in a coke blend.

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[15] ALS Coal Quality Course, Brisbane September 2022
Karr, C. (ed) (1979) Analytical Methods for Coal and Coal Production (3 volumes) Academic Press
Osbourne, D. (ed) (2013) The Coal Handbook. Woodhead Publishing. Particularly Volume 1: Coal Production.
Thomas, L. (2013) Coal Geology (2nd edition). Wiley-Blackwell

[16] Zhang et al (2025). Effect of volatile matter and ash composition on the migration of organic sulphur during pyrolysis of high sulphur coal. Journal of Analytical and Applied Pyrolysis. Volume 191, October 2025, 107222

[17] Kumar, P. & Barman, Sagar & Singh, S. & Ranjan, Menaka. (2008). Influence of coal fluidity on coal blend and coke quality. Ironmaking & Steelmaking. 35. 416-420. 10.1179/174328108X335113

Some fluidity is required in a coke blend, but excessive fluidity can lead to a weak frothy coke.

- Coal swell number (**CSN**) – the coal swell number is also known as the Free swelling index and it measures a coal's ability to swell when heated. It is a crucial indicator of a coal's coking properties.

- Petrographic properties.
  - Vitrinite reflectance and RoMAX have been discussed in **Section 2.3.2.** Vitrinite softens and swell in coke making (cf intertinites that exhibit lower or no thermoplastic properties), releasing volatiles, resulting in a strong porous carbon rich residue termed "metallurgical coke". The reflectance of the vitrinite is the key driver of coke strength, a critical requirement for coke in a blast furnace.

KEY TAKEAWAY

Coal is a complex geologic material and not all coals are the same. Coal used for steel manufacturing must have specific properties. The coal quality parameters listed above are just a sample of coal quality parameters that are used to classify and grade coal. There are additional coal quality parameters that individual steel manufacturers will focus on that are specific to their coke production and blast furnace design requirements. Depending on the coal rank, coal type and its formational location and processes, the qualities and properties of different coals can vary widely.

2.5 Difference between Thermal Coal and Coking Coal

Bituminous coal with the appropriate thermoplastic properties may be suitable to make coke, a key ingredient for iron production. Thermal coal is used for power and process-heat generation which uses a wide range of coals that may lack coking properties and/ or have other properties which are not suitable for steel making (low swell etc).

But Coke is not Coal – so what is Coke?

Coke is a grey, hard, porous fuel with a very high carbon content formed from bituminous coal. **Figure 5** presents a picture of pulverised bituminous coal and coke. Coke is formed by heating the coal in the absence of oxygen to temperatures of up to 1,250 degrees Celsius (°C), resulting in a coke, which is a porous substance that is nearly all carbon[18]. The role that coke plays in the manufacture of steel is discussed further in **Section 3.**

[18] corporate.arcelormittal.com

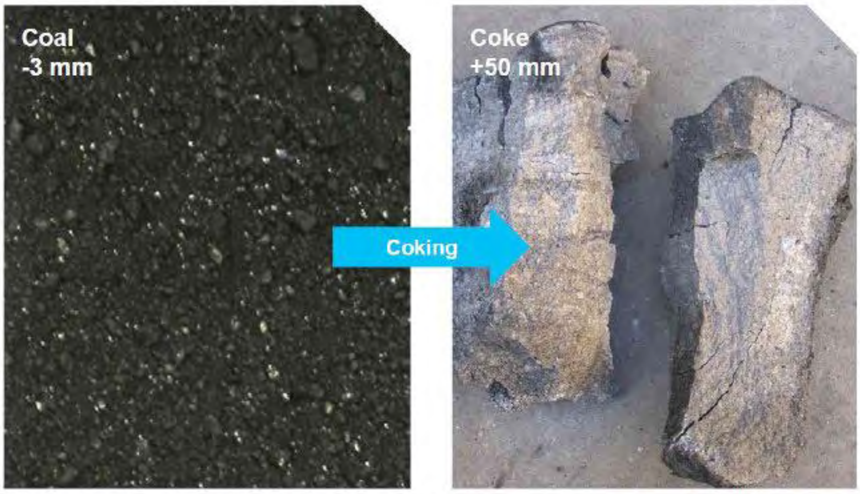

Figure 5: Representation of coal transformed into Coke[19]

The main difference between thermal coal used for power / heat generation and coking coal used for steel production is the coal's rank and quality as presented in **Table 1**.

Table 1: Main Differences between Thermal Coal and Coking Coal

Thermal Coal	Coking Coal
generally lower fixed carbon, higher ash and moisture, lower vitrinite content	higher fixed carbon content, lower ash and a high vitrinite content
does not swell very well	ability to swell, with a high "coal swell number" and indicates strong gluing properties in the coke blend
cannot transform into a viscous, molten, plastic state when heated. cannot physically transform into coke, the necessary ingredient for making steel.	ability to become molten and viscous and then resolidify to a strong porous material ability to form coke

KEY TAKEAWAY

Coking coal and thermal coal are very different materials. The properties of thermal coal cannot produce coke. Coking coal is used to produce coke which is an important ingredient for the steel making process.

2.6 Grades of Coking Coal

2.6.1 Coking Coal Grades

There are several "**grades**[20]" of metallurgical (coking) coal as presented in **Table 2**.

Table 2: The FIve Grades of Metallurgical (Coking Coal)

[19] Whitehaven Coal, Coal Quality Workshop 2023: https://whitehavencoal.com.au/wp-content/uploads/2023/06/WHC-Coal-Quality-Presentation-for-analysts.pptx.pdf
[20] https://www.bhp.com/what-we-do/products/metallurgical-coal#

Premium hard coking coal	Hard coking coal	Semi-hard coking coal	Semi soft coking coal	Pulverised coal for injection
PHCC	**HCC**	**SHCC**	**SSCC**	**PCI**
excellent coke strength a critical requirement for coking coal more expensive due to limited international resources	generally lower coke strength than a PHCC coking coal	generally commands a lower price due to its lower rank sought after to reduce ash in coking coal blends and as a binding agent	lower rank a cheaper source of carbon in the coking coal blend	required for producing blast furnace heat, carbon monoxide (as a reducing agent) as a cheaper replacement for some of the metallurgical coke requirement in a blast furnace

A mixture of coal grades are required in coke-making to make a strong coke. A single coking coal grade/type generally cannot produce the coke required for steel manufacturing. A coking coal blend is like a cake recipe: a specific mixture ratio of ingredients is required or the cake (coke) will not bake. It is not possible to make a cake with just flour; other ingredients are needed such as sugar (for sweetness), eggs (for binding, moisture and overall cake structure), baking powder (to make the cake rise and for an airy texture), butter (for flavour, mouthfeel and an airy texture). Just like the cake, different grades of coking coal are required to produce the optimal coke blend in the steel manufacturing process. However, the terminology for the "coke recipe" is called a "**coking coal blend**".

KEY *TAKEAWAY*

Coke ***is produced*** from a blend of different coals that have special properties and it is a specialised process. Coal blends are heated and must be able to melt and then reform into a strong, porous, high energy product. Coke is considered a nearly pure form of carbon.

Table 3: Baking a cake and coal blend recipe analogy

Cake v's Coke blend recipe

Cake Ingredient	Coking Coal Type	Purpose in Coal Blend
Sugar – for sweetness	Semi Soft Coking Coal (SSCC)	Adds balance and reduces cost; may improve plasticity and gas release[21]
Flour – for structure and texture	Semi Hard Coking coal (SHCC)	Provides structure; generally better thermoplastic properties to improve binding in the blend; may be lower in ash than HCC's
Butter – for airiness, flavour	Hard Coking Coal (HCC)	Essential for strong coke; high quality, supports blast furnace operations. Other, less expensive coking coals are also added

[21] Seiji Nomura, 2019, 12 - The development of coke making technology based on the utilization of semisoft coking coals; New Trends in Coal Conversion

		to the blend to meet cost and energy requirements, as hard coking coal is a scarce and high-cost resource
Eggs – for airiness, and structure	Premium Low-Volatile Coal	Enhances coke strength; low volatile matter (higher coke yield), improves steelmaking efficiency

Companies that make coke and steel purchase different coals to make up the required blend for their specific processes. **Buller Plateaux coking coals are sought after by steel producers because of the high rank (CSN** – coals ability to swell when heated, **Vitrinite and RoMAX** – see **Section 2.3.2) and low ash properties.**

KEY TAKEAWAY

There are five grades of coking coal based on various coal quality parameters. A single coking coal grade/type cannot produce the coke required for steel manufacturing. Steel manufacturers prefer certain blends of coking coal grades to suit their bespoke processes and they tend to have their own recipes. As an analogy, a cake cannot be baked with only flour.

2.6.2 Importance of Coke in the blast furnace

A blend of different coal types and grades are transformed into coke. Producing coke is a specialised process as it is important that the coke produced is able to do the following in a blast furnace[22]:

1. Provide a permeable medium to allow liquid metal to drip down to the tap holes and reducing gasses to migrate upward. A blast furnace operates at ~1600°C in the lower regions, by which stage coke is the only solid material. As a result, coke needs to be very strong.
2. Burn in the lower part of the furnace to provide heat to drive the steel making process.
3. Provide carbon monoxide from combustion in Point 2 to undertake the chemical reduction reactions with the iron ore. The more carbon available in the coke to undertake the reduction reactions the better, so lower ash coke is an advantage.

The role of coke in the blast furnace is further detailed in **Section 3.**

There are a number of coke blend design schemes that tend to all have a rank factor and a caking (thermoplastic; gluing) factor. Vitrinite reflectance (a rank indicator) is the primary driver of coke strength (**Figure 6**) and a caking index is used to assure sufficient binding in the blend.

[22]ALS Coal Quality Course, Brisbane September 2022
Chatterjee, A. & Krishnan, S.H. (2024) Insight into Coal and Coke for Ironmaking. University Science Press
Diez, M, Alvarez, R. and Barriocanal, C. (2002) Coal for Metallurgical Coke Production: Predictions of Coke Quality and Future Requirements for Coke making. Int Jnl of Coal Geology V50, p389-412
Loison, R., Foch, P. and Boyer, A. (1989) Coke Quality and Production. 2nd Edition. Butterworths & Co

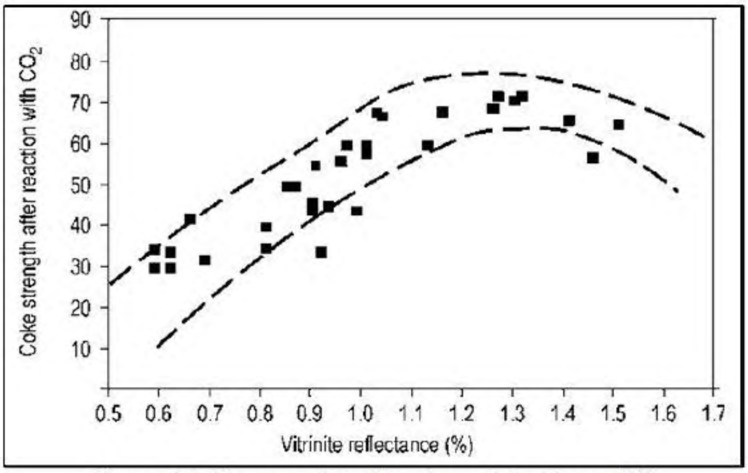

Figure 6: Influence of Coal Rank on Coke Strength[23]

KEY TAKEAWAY

Coke is produced from a blend of different coals that have special properties and it is a specialised process. Coal blends are heated and must be able to melt and then reform into a strong, porous, high energy product. Coke is considered a nearly pure form of carbon.

2.7 NZ West Coast Coking Coal – why is it sought after?

NZ's deposits of coking coals[24] are found only on the West Coast of the South Island, are relatively young[25] in age and are high in vitrinite.

The major Buller (and Greymouth) coalfields on the West Coast show rapid lateral variation in coal rank[26], reflecting the unique geological conditions during the coalification process. This has resulted in seams where coal quality changes rapidly both laterally and vertically across a deposit.

Overall, the combination of low ash, high vitrinite (rank) and extremely low phosphorus makes the NZ coking coals unique in the global market[27]. **Table 4** presents the typical Buller Plateaux coal quality parameters[28] that coking coal buyers repeatedly and specifically seek.

Table 4: Buller Plateaux Coking Coals – Typical Coke strength and coal rank

Parameter	Typical Buller Coal	Typical Australian Coal	Coking Purpose
Coke strength	55-60	55-70	Lower coke strength increases the coke rate of the furnace per tonne of hot metal (examples: +1% M25 (cold coke strength index) reduces coke rate by 3kg coke/t of hot metal; +1 unit of CRI (coke more reactive so CSR lower) increases coke rate by 1.5kg/t hot metal)

[23] 2002, Diez, Alvarez & Barriocanal

[24] Sherwood, A. (2019) The Geology & Resource of New Zealand Coalfields. Monograph 33. NZP&M/ AusIMM publication

[25] Approximately 35 million years old for the Brunner coals located on the Buller Plateaux

[26] Suggate, R.P & Boyd, R.J. (2010) Greymouth Coalfield, New Zealand: Coal Ranks in the Context of Basin Development. MBIE Unpublished Coal Report CR3388

Coal rank	0.9-1.3 RoMax	0.95-1.47 RoMax	Essential for strong coke; high quality, supports blast furnace operations. High rank coking coal allows the coke producer the opportunity to blend in lower rank coals providing a cost advantage for steel production.
Low ash	3.5% -5.5% Currently	7.5% -10.6%	Slag is a by-product of steel production and consumes some of the coking coal within a blast furnace. A low ash coking coal produces lower amounts of slag. Low ash means less heat is wasted on melting impurities, less flux (to assist melting the ash) is required, and the slag rate is lower. Reduced ash also generally improves coking coal strength by reducing impurities.
Low phosphorus	.005%	0.015%	High phosphorus content in coal is undesirable for steel production because it can make the resulting metal fragile NZ coals are very low in phosphorus (0.005%) due to their unique depositional environment.

As a result of the high vitrinite and low ash, quality is improved and the amount of fuel (coking coal and PCI) required to produce a tonne of steel is reduced. Reducing the amount of fuel required gives BPCP customers an immediate commercial benefit by reducing their coal purchases.

KEY TAKEAWAY

NZ's West Coast Coals contain very special properties for making coke and are highly sought after by the steel manufacturing industry.

3 Coking Coal essential for Making Steel

3.1 The Steel Making Process[29]

The process to generate steel, presented in **Figure 7**, commonly consists of the following basic steps:

1. The coking coal blend is fed into ovens and "coked" at ~1000-1250°C in the absence of oxygen to prevent combustion. This step produces coke (left hand image of **Figure 7)**.
2. The coking process removes volatile compounds leaving pure carbon (coke).
3. Coke is sized and fed into a ***blast furnace*** (middle image of **Figure 7** and **Figure 8**) in alternating layers with iron ore and limestone[37]. A ***blast furnace*** is a large counter-current reactor that smelts the iron ore to create pig iron that is tapped out the bottom of the furnace at ~1600°C in liquid form.
4. Pig Iron is further refined in a basic oxygen furnace to make steel where impurities are removed and alloys are added (right hand image of **Figure 7)**.

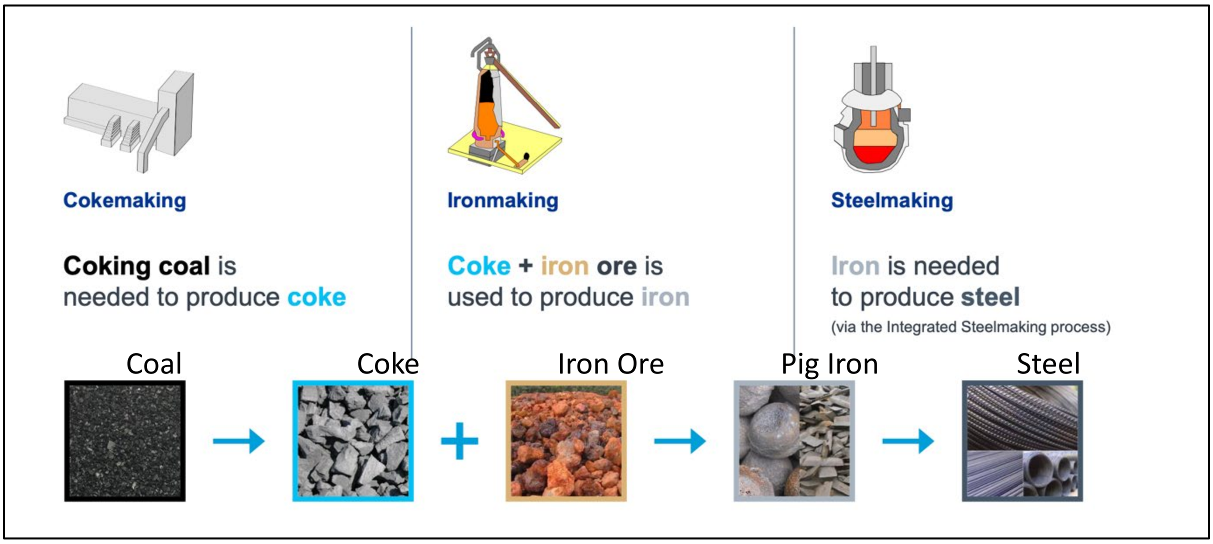

Figure 7: The Steel Making Process [30]

Figure 8 is a simple representation of a blast furnace depicting the physical and chemical roles of coke as discussed above in points 1 – 4, during the iron making process.

[29] Selected references:
ALS Coal Quality Course, Brisbane September 2022
Chatterjee, A. & Krishnan, S.H. (2024) Insight into Coal and Coke for Ironmaking. University Science Press
Diez, M, Alvarez, R. and Barriocanal, C. (2002) Coal for Metallurgical Coke Production: Predictions of Coke Quality and Future Requirements for Coke making. Int Jnl of Coal Geology V50, p389-412
Loison, R., Foch, P. and Boyer, A. (1989) Coke Quality and Production. 2nd Edition. Butterworths & Co
[30] Whitehaven Coal, Coal Quality Workshop 2023: https://whitehavencoal.com.au/wp-content/uploads/2023/06/WHC-Coal-Quality-Presentation-for-analysts.pptx.pdf
[37] Limestone is added to a blast furnace to remove impurities from the iron ore.

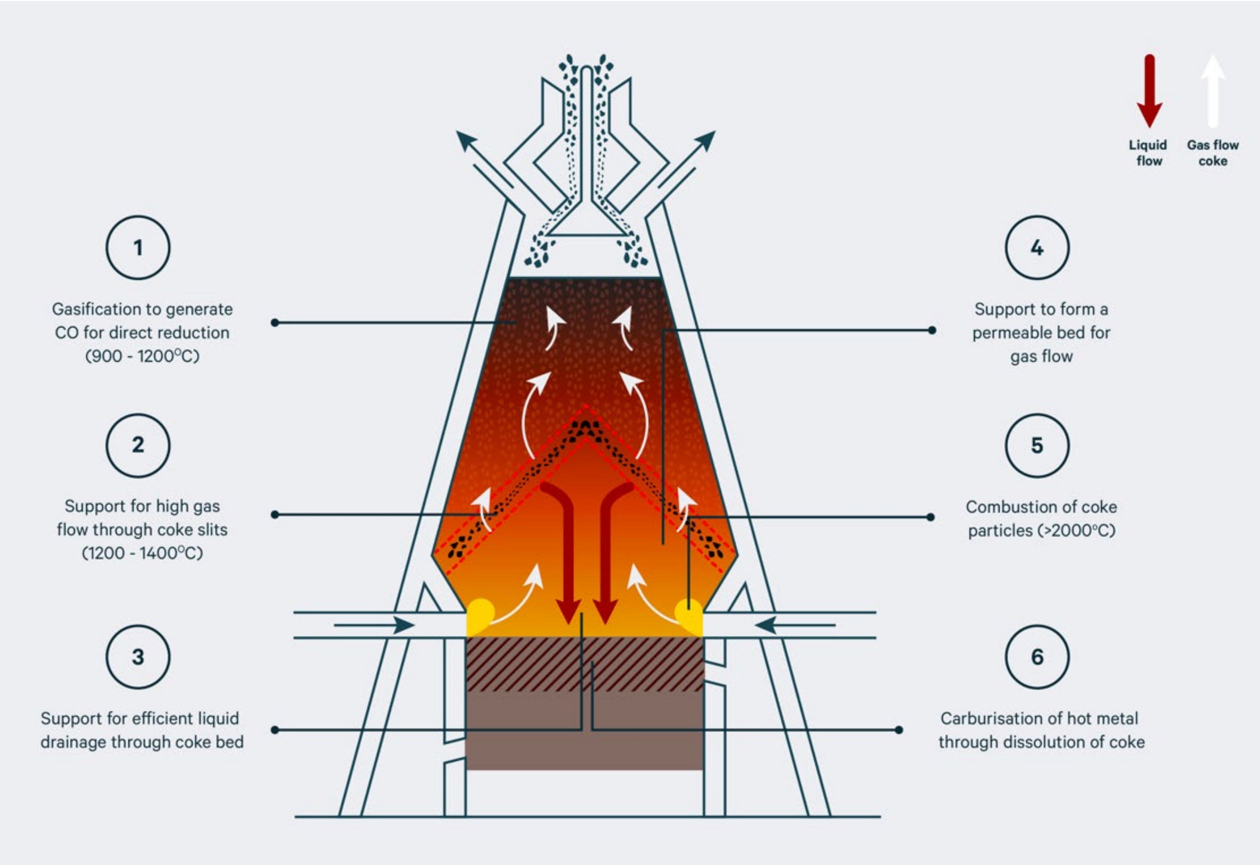

Figure 8: The Role of Coke in a Blast Furnace

In a blast furnace, coke quality is more important than ferrous material quality. The coke has three main roles including:

1. Providing a heat source.
2. Providing reductant source to aid chemical reactions occurring in the blast furnace – introduces carbon monoxide which strips the iron ore of oxygen to produce metallic iron. This process is a key step in converting iron ore into steel.
3. Creating a permeable bed during the iron making process - maintaining good permeability to allow gases to flow through, crucial for efficient heat transfer, chemical reaction and overall process performance. Good permeability reduces the pressure drop across the bed within the furnace, meaning less energy is needed to push the gases through reducing consumptive coal required.

Uses and Users of Steel

Across the world, steel is made and used for other applications including building wind turbines, solar cells, nails, fencing wire, rock bolts (to keep road cutting safe), components, boats, aeroplanes, cars and so on (see **Figure 9**).

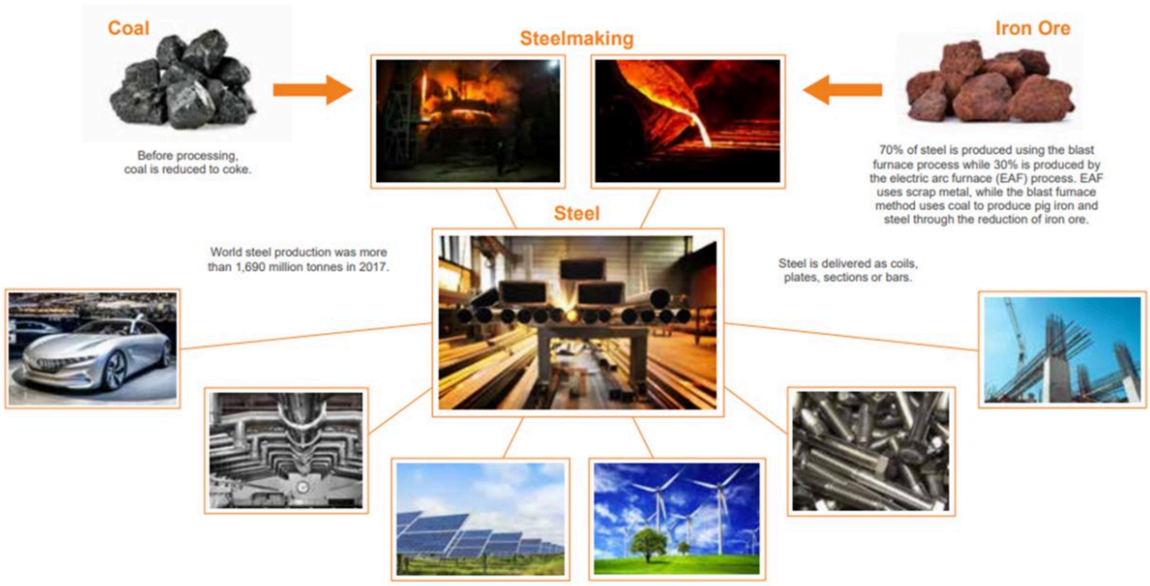

Figure 9: Steel: Raw Ingredients to Final Products

On their website, New Zealand Steel[31] produces steel for a range of industries including for the:

- Construction industry – steel framing, colorsteel® for roofing, guttering, cladding, zincalume®, galvsteel®, etc.
- Infrastructure – steltech® for bridges, hot rolled steel for beams, tanks, flanges, welded pipes.
- Farming – steel for milking sheds, equipment storage, fencing, fasteners.
- Storage – insulated panels, flooring, beams.
- Manufacturing – high strength structural applications.

The above example is from one manufacturer in NZ.

Scale of Steel Consumption – An example

To consider the scale of steel consumption, let us turn to cars in NZ alone, as an example. CEIC data report that the number of registered vehicles in NZ was 4,712,629 as at December 2024[32]. A typical NZ imported car contains approximately 800 kilograms[33] (**kg**) of steel. To make 800 kg of steel, it requires approximately 600kg of coking coal[34]. Calculating the volume of steel required to build all of NZs cars (registered as at December 2024) equates to approximately 3.8 million tonnes of steel, which would have required 2.8 million tonnes of coking coal to manufacture the steel. This is just one example of scale where steel is used for just one purpose.

Coal from the Buller Plateaux ranges from HCC (best coke strength) to SSCC, (lower rank of coal, see **Table** 2) with much of the coal being low ash. Bathurst Resources exports its coking coal to a range of international customers including steel manufacturers in India, Japan, South Korea and China. The

[31] https://www.nzsteel.co.nz
[32] www.ceicdata.com/en/indicator/new-zealand/number-of-registered-vehicles
[33] noting that the volume of steel required for a single car can range between 650kg – 1, 200 kg
[34] www.bhp.com

coking coal from NZs West Coast is highly prized sought after because it improves coke strength (using HCC) and decreases coke ash to reduce the amount of coke required to make a tonne of pig iron.

Steel can also be infinitely recycled. Iron ore is the source of approximately 70% of the metallic raw material inputs to steelmaking globally; the rest is supplied in the form of recycled steel scrap. Steel production from scrap requires approximately one-eighth of the energy of that produced from iron ore – mainly in the form of electricity, rather than coal for production from iron ore. This benefit results in high recycling rates (around 80-90% globally). However, scrap cannot fulfil the sector's raw material input requirements alone because steel demand and production today is much higher than in the past. This means that recycling alone cannot be relied upon to supply global demand[35].

3.2 Sources of Steel Production

Steel production comes from two key sources: Blast furnaces and Electric Arc Furnaces (**EAF**). **Blast Furnaces** produce what is called virgin iron from iron ore and requires coke as a reducing agent to convert the iron ore oxide into iron. **EAF's** recycle existing iron and steel (scrap steel) into new steel products. The EAF process requires very large quantities of electricity, preferably from a renewable energy source.

There needs to be sufficient quantities of scrap steel within the country's economy before it is economical to have an EAF. New Zealand Steel is currently building an EAF with commissioning due towards middle of 2026.[36] This will provide a means for recycling more domestic scrap steel in NZ, rather than the bulk of it being exported overseas to be recycled.

When a country has reached a level of steel intensity within its economy (~220kg/capita/annum in the developed world), the requirement for virgin iron decreases[37] and EAFs are used to recycle steel as it becomes available. **Figure 10** describes the steel production profile for Japan which reached a steady state of production from 1975.

Developing economies like India are below the typical steel intensity hence India and other developing countries have a growing high demand for virgin iron based on blast furnace technology that requires coking coal. Large EAF facilities for recycling of steel will come much later.

[35] https://www.iea.org/reports/iron-and-steel-technology-roadmap
[36] www.nzsteel.co.nz
[37] Poveromo, JJ, 2021, "Prospects for EAF Steel Making in Europe", Eurocoke 2021

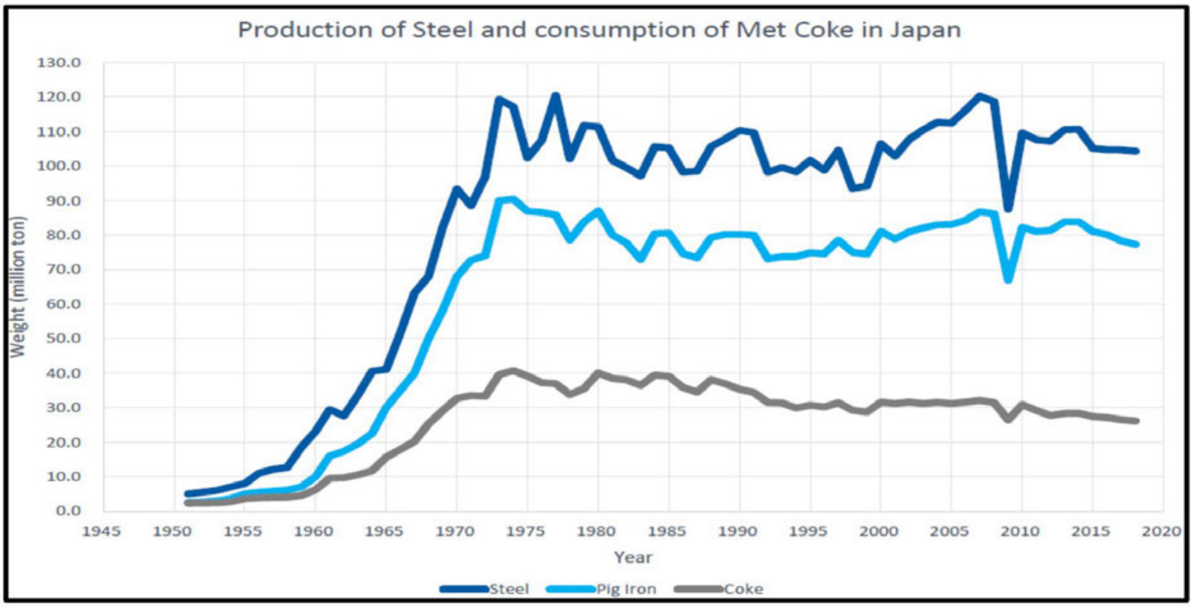

Figure 10: Demand for virgin iron does not increase indefinitely (Japanese experience)

3.3 Green Steel as an Alternative

Green steel refers to steel produced using environmentally friendly and sustainable methods. This usually involves using renewable energy sources. This can be achieved through various means such as reducing the use of carbon-based reducing agents and fuels, moving from blast furnace processes to electric arc furnaces fed with steel scrap and powered by renewable energy, converting from fossil based fuels to hydrogen (**H_2)** or electricity in downstream processing[38]**.**

Blast furnaces require coke to be used as a reducing agent (among other things) for iron production. Noting that coking coal and coke produce approximately 7% of human-induced CO_2 emissions[39] worldwide.

Hydrogen H_2 has been identified as a potential reducing agent replacement for coke in the production of iron ore (termed "green steel"). However, the production of 99% of the world's consumed H_2 is produced using predominately fossil fuels: 76% from natural gas and 23% from coal.

Another way of producing H_2 is via electrolysis. To meet the current H_2 world-wide demand would require 3,600 Terra Watt hours (**TWh**) of renewable electricity. This is more than the annual renewable energy generation capacity of the European Union. If H_2 was used across the world to make steel, then a further 2,500 TWh of clean electricity would be required to meet current global demand.

According to the IEA Sustainable Development Scenario (**SDS**) 2023, the transition to a direct reduction ironmaking coupled with EAF will take decades. Therefore, the global transition period to "green steel" is considered beyond the time scale of the BPCP.

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[38] https://afry.com/en/competence/green-steel#:~:text=What%20is%20green%20steel?,or%20electricity%20in%20downstream%20processing.
[39] European Commission (2020). Emissions database for global atmospheric research (EDGAR). http://edgar.jrc.ec.europa.eu/overview.php?v=431.

Despite these hurdles, there is growing research and development into assessing viable techniques to produce green steel, using innovative processes and technologies to significantly reduce or eliminate carbon emissions associated with traditional steelmaking.

Technical challenges in producing green steel include:

- H_2 embrittles iron leading to cracks and fractures transporting pipework. Special alloys may mitigate this problem.
- H_2 does not burn as hot as carbon and so needs heating; highly risky given the gas is explosive.
- Iron ore feedstock requires a higher grade of iron ore, 67% iron to avoid slag issues. Only 3-4% of world iron ore product meet this specification. A typical high grade Western Australian iron ore[40] is 56-62% iron and is currently only suitable for incumbent, highly carbon-intensive blast furnace technology.
- Requires a large source(s) of renewal electricity for electrolysis.

A recent Swedish steel plant conversion to "green steel" has proven some success and was aided by abundant hydroelectricity, modifications to the existing blast furnace technology requiring large capital reinvestment, available high quality ores and a large amount of European Union investment.

This single "green steel" blast furnace project resulted in approximately 25% of Sweden's output and0.06% global steel production.

4 How West Coast Coal for Steel Making is Found and Mined

Coal resources on the West Coast of NZ are identified and categorised by resource geologists with the aim of determining:

- The thickness and lateral extent of the coal seam;
- The geological structure, e.g. flat lying or dipping, location of folding of faulting (the latter ubiquitous in West Coast coal resources); and
- A range of coal quality parameters relevant to utilisation.

This process strictly adheres to an Australasian Code, known as the "**JORC Code**". Therefore, all analysis is undertaken by fully independent laboratories to comply with analytical standards and JORC[41] Code requirements.

Coal quality variations within the seam/ resource are determined by drilling and testing of cored coal seams[42]. The data is then modelled using the geological modelling package such as Vulcan[43] that employs sophisticated algorithms to extrapolate between drillholes. Outputs from Vulcan provide information on the overall coal resource, including depth of coal, coal thickness, coal quality and

[40] Nicholas, S, Basirat, S, 2023, Australia faces growing green iron competition from overseas, Institute of Energy Economics and Financial Analysis

[41] Australasian Joint Ore Reserves Committee, the JORC Code provides a mandatory reporting system for the classification of minerals Exploration Results, Mineral Resources and Ore Reserves according to the levels of confidence in geological knowledge and technical and economic considerations

[42] Cored coal seam – A cylindrical sample of the coal and surrounding rock is extracted intact from the ground.

[43] Maptek Vulcan - 3D mine planning & geological modelling

mining recovery, which then allows mining engineers to assess how the coal can be extracted economically.

This section describes the steps and processes of how coal is identified and analysed and then, how the data is used to develop a mining model.

4.1 Exploration

Exploration is an important activity to allow geologists to determine the location, depth, thickness and quality of coal deposits. Understanding the geology helps assess potential environmental risks like ground subsidence and acid mine drainage.

The objective of coal exploration is to assess:

- Prospective deposits.
- Economic coal seams within deposits.
- Nature of best reserves for mining.
- Geological and geotechnical hazards for seam development and extraction.
- Coal quality characteristics and their variation.

As each stage of exploration is completed, the reliability of site information increases. Areas of insufficient or unreliable data become more obvious, and requirements for further exploration can be described more accurately in terms of programming, timing and cost. Exploration generally includes the following activities:

- Surface mapping.
- Sub-surface mapping, (if underground mine workings are accessible).
- Drilling.
- Geophysical surveys.

These methods are summarised below.

4.2 Surface Mapping

On-ground geological mapping in promising terrain is usually the first coal exploration field activity. Outcrops are located, and their lithologies[44] and structural features described and recorded (**Figure 11**). Coal seams found are measured and sampled. Surface mapping is also very important for optimising exploration drill site selection.

[44] Lithologies – Refers to physical characteristics of rock or a rock unit such as mineral content, grain size, texture and color.

Figure 11: Geological Mapping in Rockies West Mine area

Mapping requires surveyed base topography maps of the area, or at least good aerial photograph control. Searching for old data and plans is a worthwhile exercise in areas previously mined, particularly where underground mining has occurred and old workings are likely to be encountered.

Trenching (**Figure 12**) is often required to expose near-surface coal seams and is carried out by hand digging, backhoe excavation or blasting, depending on the terrain and the sample volume requirements.

Figure 12: Trench digging

4.3 Sub-surface Mapping

Where access is available to underground exposures of rocks and coal seams, typically in stone drives and underground coal mine workings, valuable geological data can be gained by mapping the walls and roof of "roadways", (i.e. tunnels, as referred to the coal industry) if safe and practicable to do so. The principles are the same as for surface mapping, but special difficulties likely to be encountered include:

- No light.
- Obscuring of geological features by stone dust, mine infrastructure, weathered/slumped strata, lagging, water, bacterial slime, etc.
- Hazards to personal safety including poor ventilation and noxious gasses in underground workings, unstable roof and sides associated with the underground workings, potential entrapment caused by uncontrolled collapse of underground roadways, remote work, dangerous access, extreme weather.

4.4 Drilling

Drilling is the most frequent method of exploration and sampling, using either non-cored or partially/fully cored holes (**Figure 13**). Non-cored holes provide the most basic structural data and give indicative coal seam thicknesses and quality information. Extra data can be gleaned if these holes are geophysically logged by inserting an array of geophysical tools to "map" and measure various properties of the walls of the drillhole. Coring, though more expensive, gives more reliable data on coal and rocks encountered. Coring consists of cutting and maintaining in a long column, a cross sectional sample of the rock that lies above and below the coal seam (referred to as the "core"). It allows geologists and geotechnical engineers to determine rock types, thicknesses, structure and also allows geologists to carry out tests on the physical rock and coal samples (see **Section 4.5**).

Drill rigs are normally truck-transported or skid-mounted, while tracked carriers are becoming more common. In terrain which is inaccessible to tyred/tracked vehicles, skid-mounted rigs are broken down and flown to and from specially prepared sites by helicopter.

Figure 13: Helicopter supported Diamond Drilling at Mount Frederick South

4.5 Coal Quality Sampling

The sampling and analysis of coal encountered in exploration is performed in a systematic way. Sampling techniques must be statistically valid and must avoid contamination by sandstones and other non- coal materials. Coal samples are analysed to determine coal quality properties like ash, sulphur content, moisture and calorific value (see **Table 5**). Analysis standards are required to ensure appropriate controls are adhered to during analysis ensuring good governance. The coal quality parameters measured depend on the rank of the coal.

Table 5: Analytical Tests on Coal Samples

Test	Metallurgical	Thermal	Analysis Standard
Visual Description	**X**	**X**	
Chemical			
Proximate	X	X	
Moisture*	X	X	ASTM D5142-02A mod
Volatile Matter*	X	X	ASTM D5142-02A mod
Fixed Carbon* (by difference)	X	X	ASTM D5142-02A mod
Ash*	X	X	ASTM D5142-02A mod
Air-dried Moisture**		X	ASTM D5142-02A mod
Sulphur*	X	X	ASTM D4239-04A
Ultimate	X	X	ACIRL in-house/NATA
Carbon	X	X	
Hydrogen	X	X	
Nitrogen	X	X	
Oxygen (by difference)	X	X	
Sulphur	X	X	
Forms of Sulphur	X	X	AS 1038 Part 11
Chlorine	X	X	ISO 587
Ash Composition	X	X	ASTM D4326-01
Ash Fusion Temperature*	X	X	ISO 540:1955€

Trace Elements	X	X	
Calorific Value*	X	X	ISO 1928-1995
Rheological and Physical			
Gieseler Fluidity*	X***		ASTM D2639-90
Dilatation Tests (Audibert-Arnu)	X***		
Free-Swelling Index*	X***		ISO 501:2003(E)
Hardgrove Grindability Index*	X	X	ISO 5074
Petrographic			
Maceral Analysis*	X***		ISO 7404
Vitrinite Reflectance*	X***	X	ISO 7404
Notes: * Minimum test required to characterise coal properly ** Important for low rank coal samples *** Bituminous coals only			
Adapted from Table 5 in Luppens et al., (1992).			

The analysis results are crucial for deciding the best use and economics of the coal deposit, whether for power generation, steel production or other industrial applications.

4.6 Acid Mine Drainage Sampling

Acid Mine Drainage (**AMD**) is a general term used to describe waters impacted chemically by mining activities. . AMD is typically generated by the excavation of rocks that contain sulphide minerals, such as Pyrite. When these rocks are exposed to oxygen and water, they undergo weathering processes and oxidise, generating acidity and releasing toxic metals. Rock and coal analysis, modelling and prediction is critical to understanding the potential for AMD as well as the severity and longevity of AMD.

Rocks above and below coal seams (ie. waste rock) are sampled and analysed for the following tests including but not limited to :

- Maximum Potential Acidity (**MPA**): MPA measures the highest possible acidity that could be generated.
- Acid Neutralisation Capacity (**ANC**): ANC accesses the ability of the rock or coal to neutralize acids.
- Net Acid Production Potential (**NAPP**): NAPP calculates the balance between acid generating and acid neutralising components to estimate overall acid risk from the material.
- Paste Ph[45:] Paste Ph Determines the acidity or alkalinity of a paste made from rock or coal, indicating the immediate potential for acid generation.
- Rinse Ph: Rinse Ph measures the Ph of the water rinsed through rock or coal samples to assess how quickly and strongly acidity may be released to the environment.
- Stored acidity: Stored acidity evaluates the amount of acid stored in rocks or coal that could be released over time.

[45] Potential of Hydrogen": Scientific term used to describe the concentration of hydrogen in a solution, which determines how acidic or basic (alkaline) that solution is

These chemical components are estimated into the overlying and underlying rock horizons in the geological model to determine the nature and extent of acid forming rock throughout the coal deposit. The rock horizons are then characterised into the following categories:

- Non- Acid Forming (**NAF**)
- Potential Acid Forming (**PAF**)
- High Acid Forming (**HAF**)

A waste rock block model facilitates the development of a materials schedule for NAF, PAF and HAF materials which are used for mine planning. Site specific classifications are created as recommended by internationally accepted metal accounting code principles (AMIRA and price (2009) Guidelines and Mine Environment Neutral Drainage (MEND)guidelines). AMD classifications enable the modelling and preferential management for NAF, PAF and HAF materials.

4.7 Rock Strength Testing

In opencast mining, rock strength testing is crucial for highwall safety and design efficiency. Strong rocks can support steep pit walls and require more durable machinery. Weak rocks may require gentler slopes or reinforcement to prevent landslides and allow for faster excavation with lighter equipment. Knowing rock strength also helps engineers choose the right amount of explosives to improve excavation practice. It ensures effective fragmentation without over-blasting or damaging nearby structures. For example, strong and competent rock will require more explosives to break up compared to soft, highly weathered rock material.

Rock strength testing measures how much force or pressure a rock can withstand before it breaks or deforms. It helps geologists and engineers understand the mechanical properties of rocks. Strength testing is undertaken using the core (see **Section 4.4**).

Common types of tests completed are the following;

- Uniaxial Compressive Strength – Measure how much pressure a rock can take when squeezed.
- Point Load Test – A quick test to estimate strength using a small sample.
- Triaxial Test – Simulates underground conditions with pressure from multiple directions.
- Tensile Strength Test - Measure how much pulling force a rock can resist.

4.8 Ground Water Monitoring

Groundwater monitoring is the process of checking the quality, quantity, flow direction and levels of water stored in underground water bearing rocks or fissures referred to as ***aquifers***. It involves collecting data from boreholes over time.

Commonly, Bathurst will install standpipes in selected boreholes. A standpipe is a vertical Polyvinyl Chloride (**PVC**) pipe installed into the borehole to monitor groundwater (**Figure 14**). It allows water to rise inside the pipe to the same level as the surrounding groundwater body.

Figure 14: Standpipe installed at Mount Frederick South

Groundwater monitoring is especially important in opencast mining because mining activities have the potential to significantly affect underground water systems and groundwater can impact upon highwall stability.

4.9 Geological Modelling

Three dimensional (**3D**) geological modelling is like creating a digital map of the layers of rocks and coal seams below the surface. Instead of just looking at the surface of the Earth, resource geologists generate a 3D picture of the rocks, layers, and structures hidden below ground level. It helps geologists, mining engineers, and decision-makers visualise and understand the structure, composition, and distribution of rocks and minerals underground.

The data collected during the phases of exploration is collated into a digital format, validated and used to systematically construct a geological structural model. Structural models represent the geometry and spatial arrangement of geological structures. It shows how rock and coal layers are tilted, folded, broken or displaced (**Figure 15**).

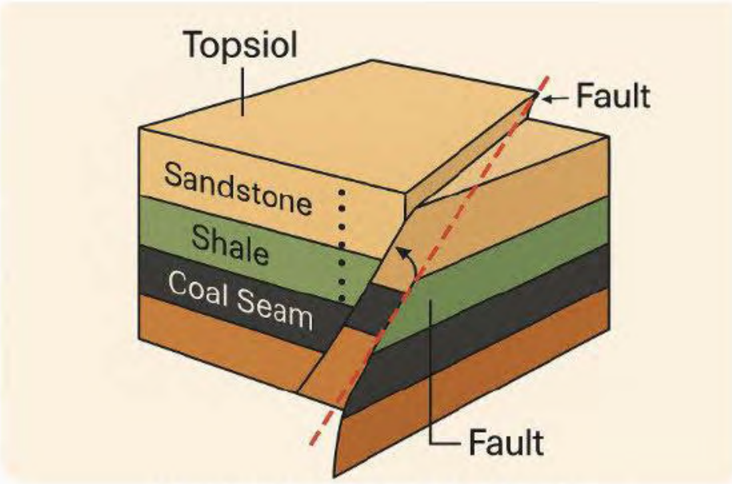

Figure 15: Structural model schematic

These models are crucial for understanding the history of an area, predicting the location of the resource, and assessing project viability and risk. Using specialised software like Maptek Vulcan three-dimensional mining software, surfaces are created to represent the different layers of rock and coal. (**Figure 16**).

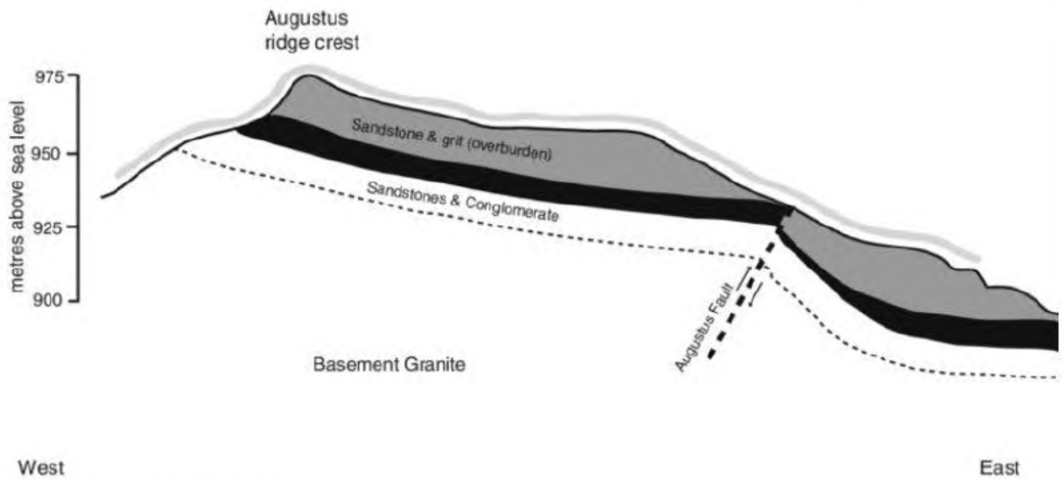

Figure 16: Typical Cross Section

Cross sections provide the resource geologist the ability to ensure coal seams are correlated between data points like drillholes and outcrop points and enable understanding of the local geology to be built into the model.

Bathurst's modelling process makes use of Vulcan Stratigraphic modelling process which converts the data and the resource geologist's knowledge into structural grids. It is like a 3D mesh or net representing the surface of rock and coal layers. Resource geologists run several iterations prior to finalising the grid surface, often refining the wide range of informing data and cross sections.

A block model provides the resource geologist the opportunity to add several fields to allow estimation of a range of attributes such as coal quality attributes, density, historical coal extraction, calculated fields to estimate remaining coal etc. The block model is then populated in the first instance by estimating coal quality and AMD attributes using advanced best practice estimation methods.

The objective is to create a model that best represents the coal seam's location, depth, thickness, coal quality properties, rock strength and AMD classifications. If the model is being used in an active mining environment, resource geologists constantly refine the model using new and actual data to produce reliable outputs that can be used by project and mining teams to evaluate and develop mine plans and mine schedules.

4.10 Converting the Geological Model into a Mining Model

The objective of converting a geological model to a mining model is to add relevant mining data to allow mining engineers to be able to use the mining model to plan the mine layout and schedule extraction.

Mining engineers develop a number of mining factors based on historical performance for the preferred mining method. For a new resource area, equivalent operational knowledge is considered and applied to the mining model.

Typical mining factors that may be considered include:

- **Coal Dilution**: the unwanted material like rock, shale or low-quality coal that gets mixed in with the coal during mining. This reduces the quality of the coal that is extracted. Think of it like getting pebbles mixed in with a scoop of clean sand. The clean sand being what is required.
- **Loss of coal due to historical mining** – underground mining may have historically occurred in the area of the proposed open cast pit, noting that some coal remains as supporting pillars. If mining engineers overestimate how much coal was left behind in these underground workings, there will be a reduced recovery compared to that modelled. Similarly, if mining engineers underestimate how much coal was left behind in these underground workings, there will be a much higher recovery compared to that modelled.
- **Loss of coal due to historical fires in old coal workings -** underground mining may have historically occurred in the area of the proposed open cast pit, noting that some coal remains as supporting pillars. This coal may have been subject to historical fires which may have completely burnt the coal or affected the in situ quality, reducing modelled recovery.
- **Mining Loss**: The portion of coal that is left behind or not recovered during the mining process.
- **Mining Recovery**: Mining recovery is the proportion of coal that is successfully extracted from the ground
- **Beneficiation Coal yields**: Refers to the amount, expressed as a percentage, of clean coal that is recovered from the raw (or run-of-mine) coal during the ***beneficiation*** process. For clarity, ***beneficiation*** means, a process used in the mining industry to upgrade the quality of the run of mine (or raw) coal or ore by separating out the material that degrades the overall product. The goal of the ***beneficiation*** process is to improve the economic value of the coal or ore by increasing the concentration of the desired component.

The final model helps mining teams make informed decisions about where to mine, how much coal to extract, and how to manage resources efficiently. It also supports financial forecasting, equipment planning, and environmental management. The model is updated regularly as new data is collected during mining.

5 Mine Planning Process

5.1 Mining Method Selection: surface or underground mining

The technical and economic feasibility of a coal resource area needs to be evaluated for a suitable mining method. There are many factors that are considered to determine the best method to extract the identified coal resource including:

- Regional geological conditions i.e. depth of coal seam, geological anomalies.
- Overburden characteristics i.e. competency of overlying rock materials.
- Coal seam characteristics i.e. Seam splitting, seam thickness, coal quality and continuity.
- Coal recovery i.e. Restrictions / opportunities associated with historic underground workings (see **Section 8**).
- Land ownership and surface environmental conditions.
- Groundwater conditions.
- Gas generation i.e. levels of methane within the seam.
- Labour and workforce availability.
- Market demand and coal price.
- Capital investment and cashflow.

Appendix 1 contains a more comprehensive description of the factors that go into selecting the most applicable mining method depending on the factors discussed above.

5.2 Mine Planning Process

The mine planning process encompasses an integrated planning process (**Figure 17**), working in a hierarchy from long term to short term. Longer-term plans set the overall strategic direction. Progressively shorter-term plans provide more operational detail and accuracy at the front end of the longer-term plans. The mine planning process consists of several steps that are often iterative and consecutive. **Figure 17** below summarises the mine planning process. Further details of each step are summarised below.

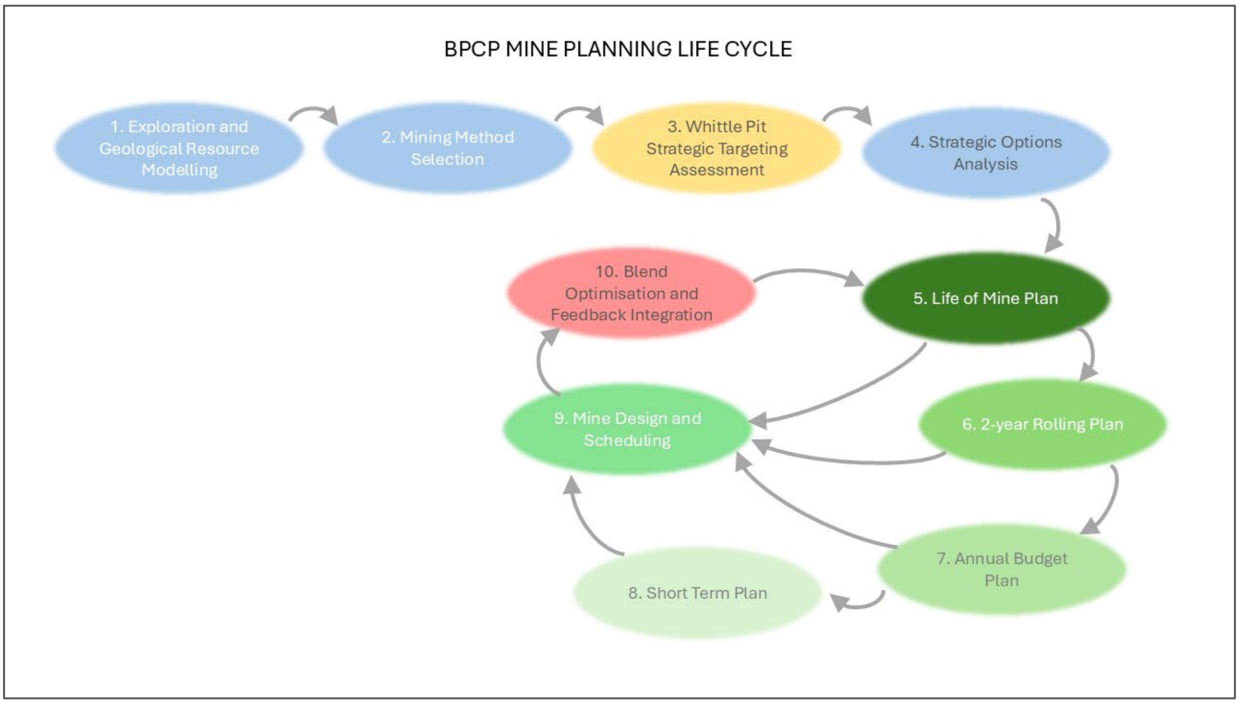

Figure 17: Mining Planning Process

Step 1 – Exploration and Geological Resource Modelling

The mine planning process starts with exploration and geological resource modelling as discussed in **Section 4**. The outputs from this process enable a determination of how much coal is likely to be available. In accordance with the JORC Code[46], a resource is estimated that meets the reporting requirements of the JORC Code[47] which has three categories based on the level of confidence (typically as a result of known data) that the resource exists and can be mined economically. The three categories include:

- **Inferred** (least certain)
- Indicated
- **Measured** (most certain)

Step 2 – Mine method selection (see **Section 5.1**)

Step 3 – Pit Optimisation Strategic Targeting Assessment

Pit optimisation software like Vulcan Pit Optimiser or software marketed by Geovia Software (Whittle optimise) are used to optimise a pit shell and mining phases to maximise the value of the coal asset using a combination of:

- economic parameters of mine costs and product revenues from sales,
- coal processing yield factors,
- geotechnical slope stability of open-pit walls

[46] The reporting of resources and reserves is controlled by an external governance body: the Australasian Joint Ore Reserves Committee (JORC) and reporting is specified and controlled by the **JORC Code. The Code** sets the rules for how mining companies publicly report **Exploration Results, Mineral Resource**s, and **Ore Reserves** in Australasia. Only a **Competent Person** can prepare and sign off on reports.

[47] Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves, The JORC Code 2012 Editon, www.jorc.org/docs/JORC_code_2012.pdf

- land disturbance and rehabilitation costs

It is effectively a "first pass" design which is followed by more detailed planning and scheduling (Steps 4 and 5). Scheduling refers to the order in which materials are worked to access the coal, extract the coal and then rehabilitate the land. Scheduling activities incorporate the selective management of PAF, NAF and HAF materials.

Outputs from Step 3 enable the initial determination of the JORC Code requirement, a **JORC Ore Reserve** which is the part of a **JORC Resource** that can be mined economically and profitably. It comes from the Measured and/or Indicated Resource categories and includes extra material that might mix in during mining, i.e. dilution material; as well as expected losses during mining, processing and blending. The **JORC Ore Reserve** is continually reviewed and evaluated as the mine planning process matures. As information and data is updated the **JORC Ore Reserve** matures from **Probable** to **Proven,** noting that to report a JORC compliant **Ore Reserve,** a Pre-Feasibility Study or a Feasibility Study showing mining is economically viable is required. As a minimum a pre-feasibility study is required to report reserves to international stock exchanges. This is required to provide confidence to investors that a reserve is based on a substantial mining study.

Step 4 - Strategic options analysis: relates to high-level decisions on how the mine will be constructed, operated, rehabilitated and closed.

Step 5 - Life of Mine Plan or **"**LOMP" has increasing detail on the mine plan from inception to mine closure, surface and ground water management and final landform design for rehabilitation.

Step 6 – Two Year Rolling Plan: provides a higher level of detail, supported by more detailed engineering work. It is updated half yearly with activities reported against it on a monthly basis. It is a regular ongoing part of the short-term planning process.

Step 7 – Annual budget Plan: provides an outline of the organisations expected income and expenses for a 12-month period. Serves as a guide for resource allocation, operational planning and financial control.

Step 8 – Three month Short Term Plan including tactical updated plans with the most accurate data and information for Operations.

Step 9 – Mine Design and Scheduling: is an iterative process using the outputs from the Whittle Pit Strategic Targeting Assessment and the Strategic Options Analysis.

Several different mine sequences and mining schedules are assessed to test blend optimisation techniques to maximise value of the different coal quality types present in the BPCP (see **Section 6.2**).

Once the blending strategy has been reached, further analysis and planning is carried out considering the following aspects:

1. Water management considering surface water, ground water and historic flooded underground workings water flow paths.
2. Mine access ramps.
3. Initial expit overburden storage areas and Engineered Land Forms (**ELF**[48]) .

[48] ELF – an Engineered Landform is a term used to describe the final landform which has been designed and constructed to be free draining and long term stable, chemically and geotechnically.

4. Haulage routes for overburden movement.
5. Haulage for coal movement.
6. Removal and placement of vegetation and topsoils.
7. Final landform design and rehabilitation including surface water controls.

Steps 1) to 7) are an iterative process with the aim of maximising the value of the coal resource through maximising the coal blended value while meeting the mine design constraints of water management, rehabilitation requirements, material movement and haulage paths.

Step 10 – Blend Optimisation and Feedback Integration: maximises mined material value by strategically blending coal from different pit sources with varying grades to meet market specifications. This process becomes a **Dynamic Feedback Loop** whereby there is continuous feedback of operational data into mine scheduling and the mine plan. This allows for adjustments of production targets and quality specifications to be continuously refined. Integrating blending and coal quality constraints into the dynamic feedback look improves mine plan responsiveness to operational and market changes.

6 Coal Extraction – Open Cut at BPCP

The BPCP proposes to extract bituminous coking coal of various grades using open cut mining techniques. **Figure 18** shows the general steps of open cut mining and generally reflects the mining processes used at the existing Stockton mine .

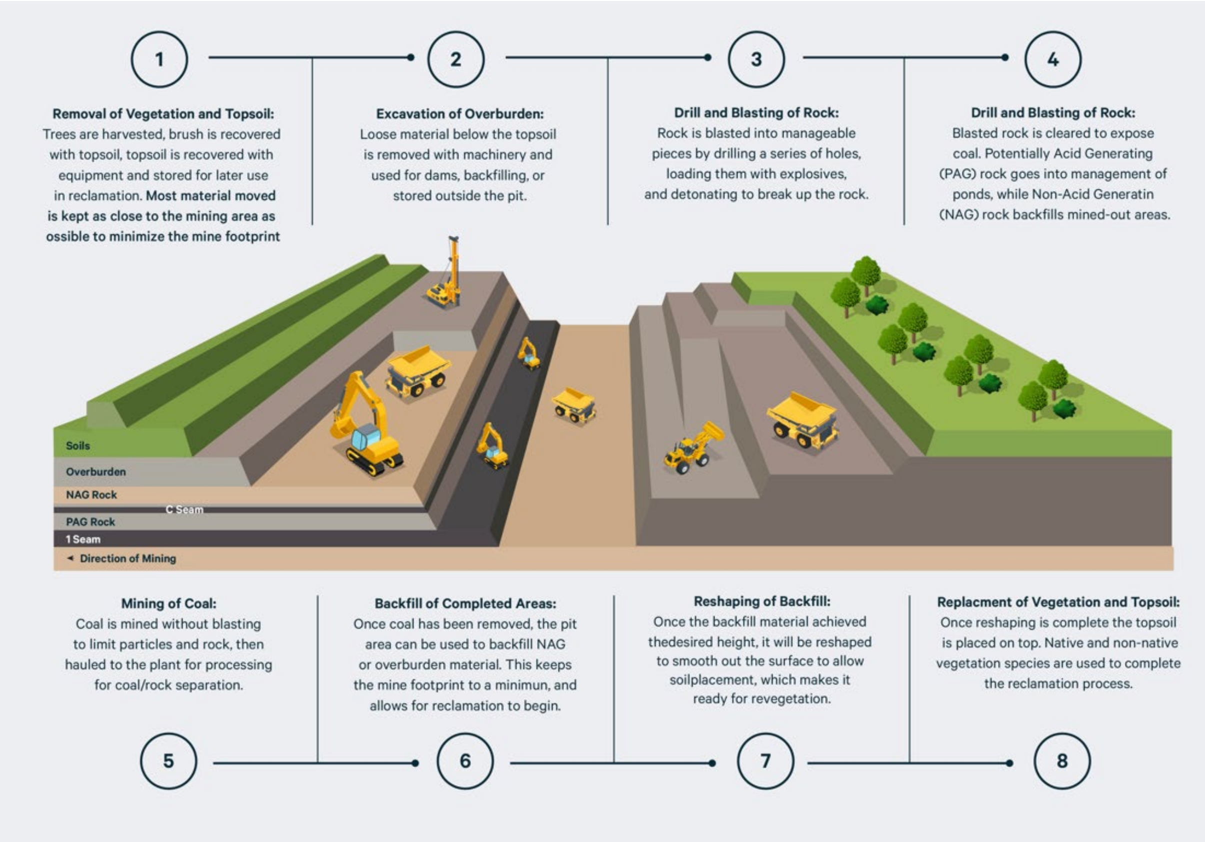

Figure 18: General Open Cut Mining Process

<u>Step 1</u> is to remove and salvage the existing vegetation and topsoils. This material can be stored in low level stockpiles or can be directly placed in areas that are ready for revegetation. The Stockton mine practises Vegetation Direct Transfer (**VDT**). VDT is the term for the process where the vegetation and the immediate soil substrate within which it survives is scraped off and then transported and placed on an area ready for revegetation (see **Figure 19**). This practice will be replicated by the BPCP where possible. This practice has proven to be successful at the Stockton mine and is carried out where possible, noting that it cannot be implemented everywhere due to scheduling constraints from the mining sequence and suitable land available and the time of Step 1: removal of vegetation and top soil.

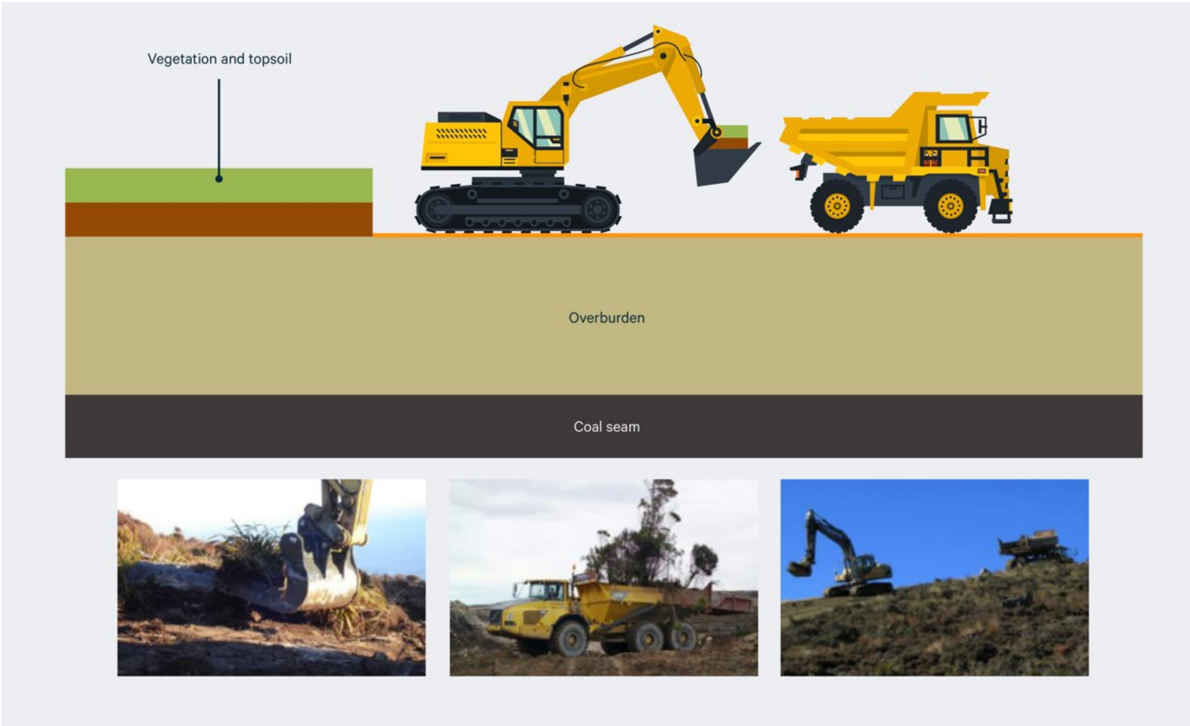

Figure 19: Vegetation Direct transfer at the Stockton Mine

Where VDT is not possible, vegetation is removed and stored - to be used as brush material and seed banks on rehabilitated lands - and topsoil is salvaged and stored in low rise stockpiles - to be used on rehabilitated lands as a vegetation growth medium.

Steps 2 - 4 is to remove the overburden to access the coal seam. Overburden is a term used to represent the layers of rock in between the surface and the coal seam. Mining operators refer to the quantities of overburden to be moved in "**bcm**" or bank cubic metres rather than tonnes. This is because the removal of the material becomes an exercise of three-dimensional size and capacity rather than weight. Removal of the rock can be done by ripping of the material using excavators, dozers and trucks to haul the material to areas where the coal seam has been removed. Ripping the rock can only be carried out where it is soft enough to do so. When the overburden rock is too strong/hard, blasting of the rock material is carried out to loosen and break up the rock in situ so that dozers and excavators are able to load the material into haul trucks for placement elsewhere **(Figure 20)**. Typical equipment size is 120-400 tonne excavators, loading into 55, 90 and 180 tonne trucks supported by 50-70 tonne sized dozers. The different sized equipment is selected based on the intended application.

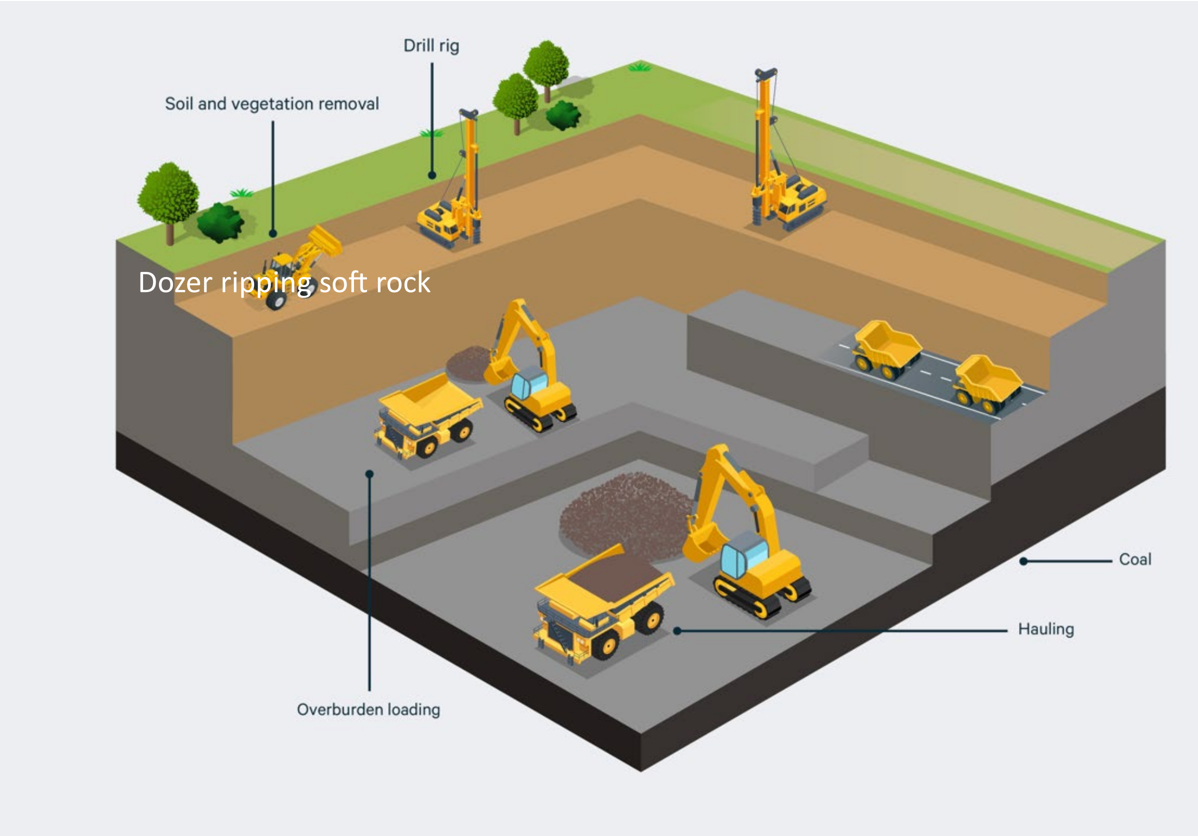

Figure 20: Removal of Overburden to access the Coal Seam:

For blasting, drill rigs drill a hole to a specific depth, explosives are loaded into the hole and when all clear, the explosives are detonated.

Removal of overburden, whether ripped or blasted, is a very precise activity as sometimes layers of rock need to be specially managed and separated. Potentially acid forming (**PAF**) rock must be kept separate from non-acid forming (**NAF**) rock. PAF rock needs to be buried and compacted at depth, often below the water table, so that it is protected from oxygen and free draining water to the greatest extent possible[49]. NAF rock is used to encapsulate the PAF rock and is used at the surface interface as it will be exposed to more oxygen.

Step 5 is the removal of the exposed coal. Coal is typically mined using smaller excavators (50 – 90 tonne excavator to load 55 and 100 tonne trucks). Coal excavated from the open pit is called "Run-of-Mine" (**ROM**) coal and it is directed to either the Coal Handling and Processing Plant (**CPP**) stockpiles for processing based on coal quality and coal types and grades or, it is directly loaded out for dispatch, by-passing the CPP. The latter ROM coal is called "**by-pass coal**" because it by-passes and is not processed by the CPP. Different coal qualities, grades and by-pass coal are stockpiled separately, managed individually and are not mixed, unless they form a specific coal blend.

Step 6 is the backfilling of the open cut pit. The backfilling is carried out to a specified design called an Engineered Landform (**ELF**). ELFs are carefully designed with input from a range of technical experts (i.e. geotechnical, hydrologists, hydrogeologists, environmental engineers etc). They are landforms that need to be stable over the long-term and free draining, so extreme care is taken in their design

[49] PAF rock exposed to oxygen will generate acid mine drainage, resulting in, if not contained and treated, acidic water drainage. Acidic water can be hazardous because it leaches and dissolves metals from surrounding rocks which can reach levels that are toxic to the environment.

and construction. Backfilling the open cut pit is not a matter of "*just dumping the rock back into the pit*".

Consideration is given to water drainage and collection from rainwater percolating through the ELF. Key ELF design elements include:

- Established construction methodology with construction in 3-5m high sections for each open pit working area. Individual ELF lift construction heights are limited to provide for increased compaction of the placed rock by haul trucks and dozers limiting permeability of the ELF to minimise surface water and oxygen ingress into the rock to limit AMD potential (see **Section 5.3**).
- Overburden rock that has been defined as PAF (see step 2) is stored in the base of the ELF.
- Overburden NAF rock is either placed on final surface layers of ELF construction or stored in designated NAF ELF locations.
- Drainage channels are designed and constructed for the surface of the ELF to allow water to freely and safely drain from the newly created topography for erosion and sediment control.
- Final ELF surface topography is designed to blend into the surrounding topography and where possible, is designed to mimic the original landscape.
- ELF construction follows the advancing coal mining face as coal is extracted.

Step 7 is final landform shaping, finessed by highly skilled dozers and excavators operators who follow the engineered design of the ELF. The landform construction is controlled using GPS control on individual earth moving machinery.

Step 8 is the placement of topsoil and vegetation. Preference is given for VDT (step 1) if available, or soil stockpiles are used to place topsoil on top of the final landform. Where VDT is not possible, planting of vegetation is carried out. **Figure 21** presents some rehabilitation activities at the Stockton mine, Photo 1 showing a replanted final landform, Photo 2 showing vegetation plantings and Photo 3 showing VDT placement.

Photo 1

Photo 2

Photo 3

Figure 21: Rehabilitation at the Stockton Mine

6.1 Coal Dilution

Coal dilution happens when unwanted material like rock, shale or low-quality coal gets mixed in with the coal during mining. This reduces the quality of the coal that is extracted. Think of it like getting pebbles mixed in with a scoop of clean sand. The clean sand being what is required.

ROM coal with dilution requires further processing in the CPP to separate out the dilution material from the product coal.

6.2 The Perfect Mix – Coal Blending

Coal blending is the process of mixing coals together after it has been extracted from the mining pit and/or processed through the CPP to achieve quality attributes (i.e. customer specification) required for the coal's intended application. The CPP carries out the beneficiation process. As a very simple example, a customer may require a low sulphur, low ash, high vitrinite coal that has minimal impurities which requires:

- a quantity of low sulphur coal (which has a higher ash level) from Pit A;

- a quantity of low ash coal (which has a higher sulphur) from Pit B;
- a quantity of high RoMAX (rank) coal from Pit C;

noting that, each of the different coals come from different mining pits.

The blending of the coals becomes a delicate balance so blending represents a challenging and complex problem with numerous possibilities, multiple constraints and competing objectives. The extraction of coal from the BPCP will occur from three different mining areas, each with varying coal qualities. This provides Bathurst with the opportunity to mix/blend coal from the different areas to meet bespoke specifications required by customers. No single mining area will be able to achieve this, so blending of the coal is fundamental to the overall BPCP's success and not without its challenges.

Blending can take place in several locations across the mining, processing, dispatch and receival chain with the location of blending sometimes being important depending on the customer's specifications (**Figure 22**). For example, blending before the CPP is sometimes needed to improve washability and increase CPP production rates and yields. The act of blending typically occurs through stockpile stacking[50] however it may also take place within a vessel's hatch during ship loading.

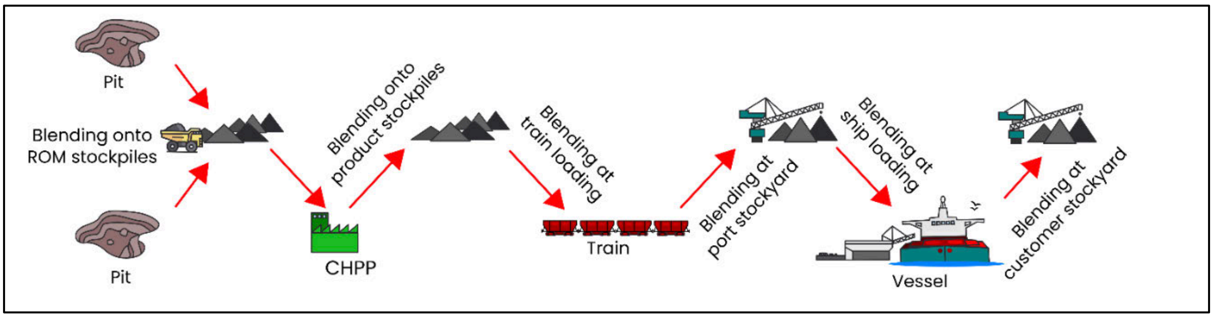

Figure 22: Coal Blending Opportunities - Mining, Processing, Dispatch and Receival Chains

Blending is a complex challenge often involving multiple coal quality parameter where the objective is typically to meet customer specifications, maximise revenue and Net Present Value (**NPV**), or monthly product tonnage targets. Important and closely related Key Performance Indicators (**KPIs**) include mining productivity, product quality consistency, and product reliability (e.g. product consistency from month to month).

Coking coal blending optimisation at BPCP considers several trade-offs:

- Costs and value generation.
- Timing of mined coal delivery available for blending and sale.
- Desired qualities for different coal products including (see **Section 2.4**):
  - Ash.
  - Sulphur.
  - Crucible Swelling Index.
  - Volatile matter.
  - Inherent Moisture.
  - Total Moisture.

[50] Stockpile stacking is the process of piling coal of a similar quality or specification into large mounds for storage, using machines called stackers. Various proportions of the stacked coal can be blended to achieve an overall coal quality required by a customer.

- Coal rank, measured by reflectivity (RoMAX).

- CPP yield performance where high ash material and dilution sandstone rock is separated from coal.
- Market and customer specific demand.
- Maximising value generation by the differing coking coal categorisation products.

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

BATHURST RESOURCES LIMITED

7 Coal Processing

7.1 Existing Infrastructure

The Stockton Coal Processing Plant (CPP, see **Figure 24**), operational since 2010, will continue to be used for Stockton, Cypress and both Mount Frederick South and Escarpment Extended coals. The plant consists of three major process circuits:

- [redacted]
- [redacted]
- [redacted]

Coal is transported from the CPP using 90 tonne trucks via a 7.3 km haul road to the aerial ropeway. The aerial ropeway conveys coal to the Ngakawau rail loadout facility.

[redacted]

[redacted]

[redacted]

[51] A rotary breaker is a large industrial machine that is used for crushing and sizing coal and/or rock, and can separate some waste material from the usable product. It consists of a large rotating cylinder that effectively breaks the rock into smaller pieces and separating softer coal from harder stone/rock.

[redacted]

[redacted]

7.4 Coal Rejects Management

Coal rejects are separated waste material from the coal products. Typically, coal rejects contain high ash coal, mudstone partings from within the mined coal seam and sandstone dilution from the mining process. Higher dilution occurs where underground workings are present.

[redacted]

For the BPCP, future CFSF storage is planned at A-Drive (**Figure 27**). The proposed A Drive Sumps/Borrow Pit stages 2 and 3 are estimated to have a combined excavation volume of approximately 1.9 million bank cubic metres (MBCM) dominated by granite resource. The excavated pits will be repurposed for coal fines storage and will have a combined storage capacity of approximately 950,000 m^3 assuming a freeboard of 4 metres. All A Drive CFSF's will be excavated below ground level and will not have engineered embankments and thus do not qualify as dams.

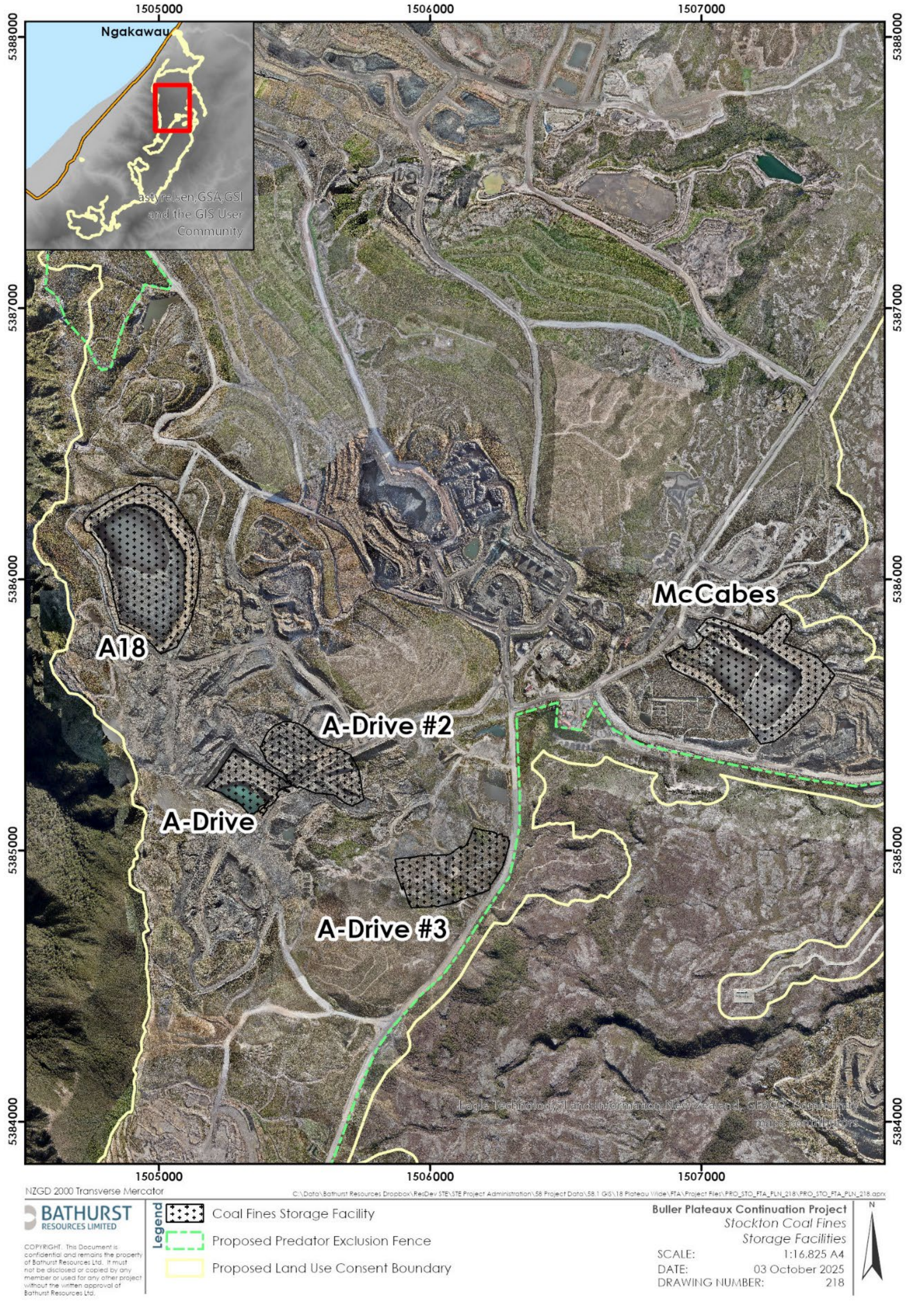

Figure 27: A-Drive Coal Fines Storage

8 The Challenges of Mining on the West Coast

8.1 Brief History of Mining on the Plateaux

Coal mining has a long history in the Buller District, dating back to the opening of the first mine there in 1864. Prior to World War II, all coal was produced by underground methods, but since 1975, opencast mining has accounted for 95% of production.

Coal mining and its associated infrastructure developments – roads, railways and the port – were the foundations of the town of Westport. Gold was worked in the Cedar Creek saddle area in the 1860's and coal mining began at Burnett's Face near Denniston in 1882. The coal field now covered by the Stockton mine has been mined since 1890.

The Crown, through State Coal Mines, first acquired mines on the Stockton Plateau in 1944 and immediately commenced a large-scale development programme, which included a shift from underground mining to opencast mining. This enabled the Crown to increase the rate of coal removal, a trend which would continue through the 1990's and 2000's. **Figure 28** presents a photograph of open cut mining, under the control of the Crown at Stockton from May 1948.

Figure 28: Open cut mining at Stockton, May 1948

By 1985, it is estimated that around 1 million tonnes of coal had been excavated from Stockton mine by opencast methods. By 1990, this had grown to half a million tonnes of coal mined per year, and by the mid 2000's, coal extractions reached a peak of two million tonnes per year. To date, approximately 28.5 million tonnes of coal has been extracted from the Buller Plateaux.

Figure 29 presents existing known underground workings across the Buller Plateaux in the Stockton Mine area shown by the black hatching. **Figure 30** presents underground workings across the Denniston Plateau. The location of these historic workings is important because the BPCP open cut mining activities will interact with them.

[redacted]

[redacted]

The historic underground workings only extracted part of the coal resource. There are still pillars of coal in-situ that remain and can be extracted. Many of these old underground workings are flooded as water has flowed into the voids created by the mining process. The BPCP will be open cut mining in and around these historical workings. This will present its own set of challenges as explained in the following section.

8.2 Underground Workings

As presented in **Figure 29** and **Figure 30**, there are underground workings present within the BPCP mining areas, so whilst this presents an opportunity to extract the remaining pillars that were left behind, it also presents significant operational challenges that need to be managed**.** Principal challenges relate to[52] :

- Lack of information on the old workings – there could be a paucity of information regarding the state of the old pillars and the general conditions of the workings.
- Spontaneous combustion.
- Sinkholes and surface subsidence in the old workings.
- Incompetent roof beam and highwall.
- Excessive dilution.
- Fire affected coal impacting on coal quality.
- Pit flooding.
- Acid Mine Drainage (**AMD**) where the relevant conditions exist.

Bathurst and BT Mining are experienced in managing these challenges as we have been working in and around historic underground workings for decades at Stockton as well as at other mining operations around NZ. To this end, and in addition to site specific risk assessments and hazard identification, existing operational controls in place will be employed at the BPCP to manage the challenges noted above.

8.3 Existing Acid Mine Drainage

The oxidation of PAF and HAF rocks and the consequent release of acid drainage is a natural process, referred to as "acid rock drainage" (ARD), which normally occurs slowly as the surface of the earth erodes and the underlying rock oxidises[53]. The term (**ARD**) includes all processes whereby sulphide rich (ie. PAF and HAF) rocks are exposed to oxygen and water and can occur without mining as part of normal geological weathering. Bedrock buried in the Earth is chemically stable as it is not exposed to air, but when it becomes exposed to air and water the rock becomes destabilised through chemical and physical changes. Mining operations can accelerate the oxidation process by providing flow paths (Department of the Environment, 2021) that accelerate the process of acid rock drainage which is referred to as "acid mine drainage" (AMD).

[52] Ngwenyama, P.L. and Graaf, W.W (2021). Risks and Challenges affecting opencast pillar mining in previously mined underground bord and pillar workings. Journal of the South African Institute of Mining and Metallurgy. Vol.121, No. 12, pp.623-633

[53] Department of the Environment (2021). Acid mine drainage in Australia: Its extent and potential future liability. https://www.dcceew.gov.au/science-research/supervising-scientist/publications/ssr/acid-mine-drainage-australia-its-extent-and-potential-future-liability accessed 10 August 2025.

For both ARD and AMD, sulphide minerals can break down, producing acid which reacts with rocks, dissolving other metals into solution and being transported away in the water. This process is known as “metal leaching”. ARD and metal leaching are complex processes which involve several chemical, biological and electrochemical reactions with the rate of reaction dependent upon many factors including:

- the morphology of the sulphide rich rock.
- presence of oxygen.
- presence of bacteria.
- presence of acid-consuming materials – materials with the capacity to neutralise acid.
- presence of water.

Identifying PAF, HAF and NAF rocks is critical to mine planning and the following activities are carried out to understand the potential for these rocks to exist within the proposed mining area:

- A geochemical baseline programme focuses on understanding the chemical composition of materials to be mined (e.g., waste rock, see **Section 4**). This information determines the potential of these materials to release acid and metals into the environment.
- The results of the geochemical characterisation will provide input into overburden rock placement and water management planning, as well as to inform closure and rehabilitation planning.
- A robust geochemical characterisation programme is used to build a model of the different geochemical rock types.
- The geochemical characterisation programme is ongoing with the mining operations to validate, maintain the database of PAF and NAF rock and its location and update the geochemical model
- The geochemical model is used to determine where the differing overburden rock types will be placed when mined and emplaced during rehabilitation.
- Historic underground mining on the Buller Plateaux has a strong influence on ground water flow paths. The historic underground workings are considered in the mine planning and design process.
- The hydrogeological baseline programme focuses on the quality, distribution and movement of groundwater, which will provide input into the mine design, including site layout, overburden rock placement, water management and rehabilitation.

Controls and mitigation measures typically implemented to manage PAF rock may include (**Figure** 31):

- Segregation of PAF rocks and NAF rocks once exposed.
- Placement of PAF rock under groundwater levels to minimize exposure to air and oxygen.
- Sealing of underground workings (if present) to restrict the escape of acidic water and/or restrict the ingress of oxygen.
- Encapsulation and compaction of PAF rocks at depth within ELFs.
- Encapsulating compacted PAF rocks by a cover of compacted NAF rocks.

- Neutralising PAF rocks via the addition of acid-consuming materials such as lime, mixed in and compacted within the rock matrix.
- Directing water drainage from PAF rock areas to containment ponds with water treatment to neutralise acidic water and collect sludges (i.e. metals and materials that precipitate out of the formerly acidic waters). Water treatment options may be “active” or “passive”.

The potential for AMD is considered at every stage of mine development, operation and reclamation (rehabilitation) by ensuring mined materials are characterised and proactive measures such as those listed above (see also **Figure 31**), to minimise AMD are included in the design.

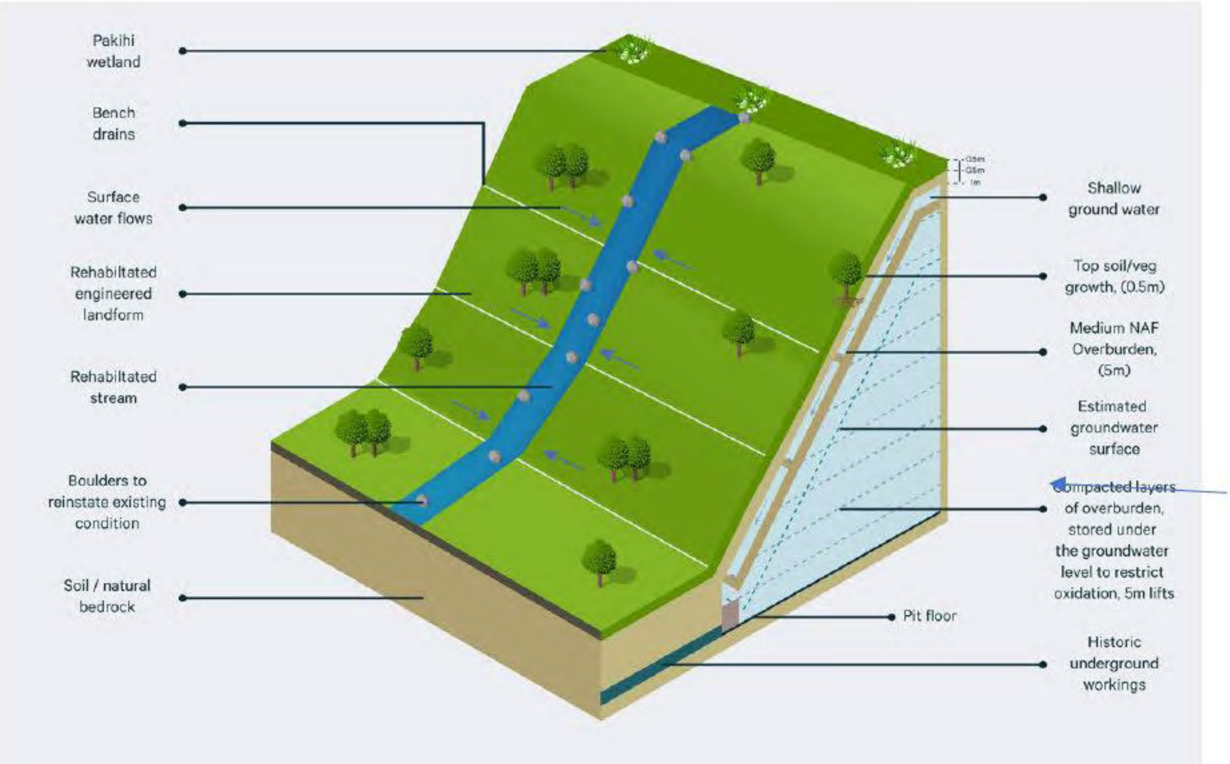

Figure 31: Conceptual ELF Design - Segregation and Management of PAF and NAF rocks

Bathurst and BT Mining are experienced in treating and managing AMD where it exists. Management ranges from “Active Treatment” processes to “Passive Treatment” processes. “Active Treatment” includes physically dosing neutralising chemical followed by physical and chemical mixing and settling processes. “Passive Treatment” includes allowing the water to filter through a medium such as Mussel Shell Reactors[54] (**MSR**) which neutralises the water, allowing solid precipitates to settle out, generally without the need for continual intervention. Both “Active and Passive Treatment” facilities are operated and monitored by experienced personnel.

[54] Weber et al, 2016, Novel cost effective full scale mussel shell bioreactors for metal removal and acid neutralization

9 Buller Plateaux Continuation Project – Meeting the Challenge

9.1 Meeting Customer Specifications – BPCP Interdependencies

[redacted]

As discussed in **Section 2.6**, steel manufacturers all have their own recipe for making coke (i.e. coal blend) required to make their steel. Buller Plateaux coals vary in coking properties and coal quality across the Stockton and Denniston plateaux. This requires careful blending strategies that govern the mine plan, and mining sequencing, coal processing requirements and timing of extraction to ensure customer blends can be delivered.

Coal from the Buller Plateaux is mined from seams using open pit mining methods. Excavated coal is separated (processed) from overburden rock material to prepare it for commercial use. Coal quality, ash, sulphur, volatiles and coal rank, are all key considerations (amongst others) to make a suitable blend for steel producers. For this reason, coal quality parameters are sampled, analysed, interpreted, modelled, interpolated and mapped across the differing mining areas based on coal testing results obtained from exploratory drilling and in pit testing. **Figure 32** and **Figure 33** show the variation in just two coal quality parameters from the Denniston Plateau; **Figure 32** presents the variability in RoMAX and **Figure 33** presents the variations in volatile matter. Similar variations exist for other coal quality parameters. The different colours presented in both figures depicts the varying qualities.

[redacted]

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[redacted]

The coal to be extracted from the BPCP mining sub-areas all have varying qualities and need to be blended to meet customer specifications. The blending of coals from the various BPCP mining pits are depicted in the Sankey Diagram presented in **Figure 23** of **Section 6.2**. Plans and schedules are prepared on how, where and when the coals from the various mining pits can be extracted and blended to meet customer specifications and requirements. This requires multiple working pits to be in operation at any one time.

Getting the product blends right requires meticulous planning and timing using experienced personnel to make sure the required proportions of the various coals are extracted at the right time and at the required volumes with minimal dilution. Coupled with ELF design, pit backfill, segregation and management of PAF and NAF rocks, rehabilitation, VDT; these mining processes require a skilled multi-disciplinary team. Importantly, without the variety of coals on offer at any time from each of the mining pits (Escarpment Extended, Mount Frederick South, Cypress and Stockton), product blends required by customers will not be able to be met. [redacted]

9.2 Greenhouse Gas Benefits

Bituminous coal from the Buller Plateaux has unique properties and for this reason, the coal products and blends are highly sought after by steel manufacturers around the world. The purpose of this section is to provide examples of why coal from Buller Plateaux is a sought after commodity.

Minimises Greenhouse Gas Emissions

An independently verified analysis of coal from the Buller Plateaux[55], has validated that overseas steelmakers avoid emitting 195,000 tonnes of CO_2 per year because of its unique properties. It is well established that the high vitrinite and low ash properties in coal from the Stockton mine (specifically the "Alpine Blend") offer fuel savings to customers when compared with other seaborne coking coals, and therefore lower carbon dioxide emissions per unit of steel they produce.

[55] SGS unpublished report, 2012, Calculation of New Zealand Export Coking Coal Carbon Dioxide Emission Savings.

A study carried out in 2021-2022, quantified the emission savings by using one of Bathurst's iron and steel manufacturing customers in India as a case study. They opt to blend the "Alpine Blend" product with Australian and Indian coals, precisely because Stockton's low ash and high vitrinite content coal:

- Reduces their fuel use,
- Reduces the rate of slag formation in the furnace,
- It also improves the coke strength in the furnace; and
- Reduces their overall fuel use, saving on costs.

Bathurst's analysis confirmed that at this single steel manufacturing plant alone, the benefits of using the "Alpine Blend" product amounts to an annual reduction in CO_2 emissions of 145,000 tonnes ("t CO_2"). This reflects a reduction in the blast furnace fuel rate of 14.24 kilograms of coal per tonne of hot metal produced, at an annual plant production of 3.6 million tonnes ("Mt") of hot metal.

[redacted]

In the early years of the BPCP plan, the emissions reduction delivered by continued sales of low ash coal (dominated by Stockton area production) remains substantial at ~270,000t/annum emissions.

Once the Alpine product is removed from the product mix the annual estimated emissions reduction drops to ~200,000t/annum. In the final 5 years of production, that focus on a specific premium coking product mix proposed for the BPCP project (Whareatea Hard Coking Coal product) emission savings are further reduced to ~120,000t per annum.

Independent verification of these results has been obtained from SGS Laboratories Limited. The report states "*the derived emissions reductions are fairly calculated for the Alpine blend*", which refers to Stockton's export coal specification.

At present, bituminous coal remains an essential input into the steel industry. The International Energy Agency projects demand for steel to increase by a third by 2050[56]. To this end, Bathurst Resources plays a role in supplying coal required for steel manufacturing to customers, who can now quantify their emissions reductions from using the "Alpine Blend" product. The BPCP will extend this benefit out to 2029 through the ongoing supply of the "Alpine Blend" and beyond 2029 with its other coal blends.

[56] https://www.iea.org/reports/iron-and-steel-technology-roadmap

10 Conclusion

The Buller Plateaux Continuation Project represents a uniquely valuable opportunity for New Zealand's mining sector and for the global steel industry. The geology of the West Coast has produced rare, high-quality bituminous coals with exceptional coking properties, characterised by high vitrinite content, low ash levels and favourable rank profiles. These qualities make Buller Plateaux coals highly sought after by international steel manufacturers, who rely on consistent, high-performance blends to maintain efficient and economic blast furnace operations. The scientific, technical and operational processes described in this report clearly demonstrate the depth of expertise required to identify, extract, process and blend these coals to meet stringent customer specifications.

As outlined, the BPCP can only realise its potential when all mining sub-areas—Escarpment Extended, Mount Frederick South, Cypress and Stockton—operate in an integrated manner. Each contributes essential coal qualities needed for the complex blending requirements that underpin customer contracts and product value. Without this multi-pit approach, the premium blends that underpin economic viability cannot be produced.

Mining on the West Coast presents significant technical and environmental challenges, including complex geology, historic underground workings, rock strength variability, and the need for robust acid mine drainage management. Through the application of disciplined geological modelling, advanced mine planning, structured waste rock management, engineered landforms, and ongoing environmental monitoring, Bathurst and BT Mining have demonstrated the capability to manage these challenges responsibly and effectively.

The project also delivers wider benefits beyond the mine gate. High-rank, low-ash West Coast coal directly reduces emissions for global steelmakers by improving coke strength, reducing slag volumes, and lowering total fuel consumption. Independent analysis confirms that the premium "Alpine Blend" alone enables hundreds of thousands of tonnes of CO_2-equivalent emissions to be avoided each year—a meaningful contribution during a decades-long global transition toward lower-carbon steelmaking.

Ultimately, the BPCP continues a long legacy of coal extraction on the Buller Plateaux while applying modern science, engineering and environmental stewardship. The project supports regional employment, contributes to national economic growth, and plays a critical role in supplying high-quality coking coal essential for global steel production—a material central to infrastructure, technology, manufacturing and modern life. The combination of rare resource characteristics, disciplined planning, and responsible operations ensures that the BPCP can meet both economic and environmental expectations while delivering a product integral to global development.

Appendix 1

Mining Method Selection: Surface or Underground Mining

The technical and economic feasibility of a coal resource area needs to be evaluated for a suitable mining method. There are many factors that are considered to determine the best method to extract the identified coal resource including:

- Regional geological conditions ie. depth of coal seam, geological anomalies
- Overburden characteristics ie. competency of overlying rock materials
- Coal seam characteristics ie. Seam splitting, seam thickness, coal quality and continuity
- Coal recovery ie. Restrictions / opportunities associated with historic underground workings
- Land ownership and surface environmental conditions
- Groundwater conditions
- Gas generation ie. Is methane inherently high within the seam
- Labour and workforce availability
- Market demand
- Capital investment and cashflow
- Health and safety issues

Table 6 describes the high-level ranking assessment for considering the application of surface and underground mining methods.

Table 6: Mining Method Selection Criteria

Mining Method Selection Criteria	Surface Mining	Underground Mining
Regional geological conditions;	Improved ability to sequence mining around variable geological conditions and work around or mine through fault zones. Coal seams are relatively shallow that preclude.	Less flexible to mining sequence around geological conditions, standoff distances from adverse underground features and loss of coal reserves around faults.
Overburden characteristics;	Competent rock amenable to stable walls for opencast mining; Bathurst holds many years of mining in similar conditions.	Relative competent rock for underground mining.
Coal seam characteristics including seam continuity, thickness, structure, coal quality, coal quality continuity and depth;	Opencast mining flexible to coal seam spatial variability and coal quality variability.	Not flexible to changing conditions. Underground mining in NZ has always struggled with coal seam physical and spatial variability. Overseas mining jurisdictions, e.g. Australia, do not have the same level of structural variability.
Coal mining recovery differences across surface and	High level of coal seam recovery using opencast	Lower coal seam recovery with underground mining.

differing underground mining methods	mining techniques. Bathurst has proven record of coal seam recovery of previous underground mind areas and managing hot zones and active open fires in underground worked areas.	Loss of coal on the coal seam roof and floor that is left for underground opening support Lack of ability to respond to hot ground and open fires in previous underground worked areas Nil ability to mine in and adjacent to previously worked underground mined areas. Previous underground workings are dangerous in the confined spaces of underground mining.
Strength of materials above and below the seam for roof and floor conditions;	Amenable to opencast mining techniques.	
Topography, especially altitude and slope;	Amenable to opencast mining techniques.	
Surface environmental conditions from surface and underground mining.	Large impact caused by opencast mining that is mitigated by proven Stockton rehabilitation practices on surface mining I timeframes of years to decades. Able to correct poor outcomes for surface water discharge and surface disturbance in previous underground worked areas.	Lower impact to surface effects from underground mining. However previous studies indicate the economics do not stack up. Not able to mitigate the surface water discharge and surface disturbance in previous underground worked areas.
Climate;	Proven ability to work in the subalpine environment.	Proven ability to work in the subalpine environment.
Land ownership and land access as it affects the availability of land for mining and access;	Land access has been granted in prior cases for surface mining on Crown land managed by Toitū Te Whenua Land Information New Zealand (LINZ) and Department of Conservation Te Papa Atawhai (DOC) subject to suitable bonding and access fees.	
Surface drainage patterns;	Surface drainage patterns require reinstatement following opencast mining and for a key part of final landform design and rehabilitation.	Surface drainage patterns are likely to be disturbed from subsidence caused by underground mining, especially so given the shallow nature of the coal seams of interest. Surface water features require reinstatement following underground mining.
Groundwater conditions;	The ground water conditions within the area of interest on the Buller Plateaux has been impacted by previously	Underground mining presents limited capability and opportunity to control and capture underground water for

	underground worked areas and causing AMD waters to leach from the uncontrolled underground drainage flow into surface streams. Opencast mining will take control of the underground drainage flows and provide opportunity to either block off the drainage paths or intercept the AMD groundwater for active and passive treatment. This is practiced at the Stockton Mine.	active and passive water treatment.
Availability of skilled labour and materials;	Skill operating workforce present drawing from the Stockton Workforce, practices and experience gained over many years.	Very limited skills in New Zealand for underground coal mining. Many people have left the NZ coal mining industry after the closing of the underground coal mines of Spring Creek, Roa and Pike River. It would be difficult to reintroduce the skills and work culture required for underground coal mining in New Zealand The NZ mining conditions are different to typical mining conditions experienced in Australia and South Africa.
Coal purchaser specification requirements in terms of tonnage, quality, and destination.	Experienced techniques and flexibility with opencast mining to match the variable coal quality on Buller Plateaux coals to market requirements.	Blending techniques would be similar however underground mining is much less flexible to coal quality variation experienced within th e seam from roof to floor as well spatial extents of variability.
Capital investment requirements and timing of cashflows during mine development and mine production.	Lower capital investment required, higher operating cos when strip ratio of waste: coal gets high	Larger upfront capital investment required to establish an underground mine's infrastructure and initial development requirements. Lower production costs come from pillar extraction activity
Health and Safety Issues	All the normal H&S issues around extractive activities but without the added risks of explosions in a mine	Issues around gassy mines and dealing with methane. Previous coal mining disasters have related to underground

		coal mines e.g. Strongman mine and Pike River Mine

For the BPCP area, there are significant areas of underground workings within the coal resource area. The presence of the underground working precludes the ability to safely mine these areas using underground mining methods. The areas that do not have underground workings have been left for either coal seam structural reasons (faulting, narrow seams) or coal quality reasons.

Appendix B: Historic Underground Workings

[redacted]

[redacted]

Appendix C: Summary of Activity Data Provided by Bathurst

Historical Stockton Activity Data

Table C1 presents the historical data used for calculating pro-rata rates, which were applied to estimate future diesel, heavy oil, petrol usage within Stockton sub-area. Electricity pro-rata was applied to all pits.

[redacted]

[redacted]

[redacted]

[redacted]

Number of Staff

The number of staff at each sub-area was used to estimate wastewater treatment requirements and therefore emissions from wastewater treatment.

The predicted number of FTE is predicted to remained fixed over the course of the project as no future staffing prediction have been undertaken, however, in reality this number is expected to fluctuate each year. It is also likely that contractors will use these facilities, however the number of staff is unknown and therefore excluded from this assessment.

Table C5: Predicted Number of Staff Onsite

Location	FTE[1]/Day using facilities	Manning
Stockton	421	Stockton (Bath house office complex, Top offices complex/hoods, Campbells Crib-hut, Downers old workshop, Stockton alliance workshop, CHPP, Sub-contractors' complex limbo, Orica compound, Station 2, electrical workshop, BWTP, Gatehouse, Red rocks crib hut), Ngakawau (Bath house, offices, Tub shop, Station 5, SGS Lab). This data considered shift patterns and site visitors.
ESE	416	ESE included administrators and security, central operators, central workshop technicians, eastern coal haul, and other miscellaneous teams, accounting shift pattern contingencies and site visitors. The MFS FTE were included in this number.

Notes:
1. *Full Time Equivalent*

[redacted]

[redacted]

[redacted]

[redacted]

Appendix D: Verification of Fugitive Coal Seam Gas Emission Factor

Buller Project Coals - Toward a Unique Emission Factor

At the current time, the New Zealand government charges a fugitive emission ETS tax based on nominal figures laid out in Figure 1.

Figure 1 – Nominal Fugitive Emission Factors

Table 3
Fugitive coal seam gas

Part A—Underground and surface mining

Category of coal	Emissions factor	Unit
Coal mined from surface mining	0.024	tCO_2e/t coal
Bituminous coal mined from underground mining	0.514	tCO_2e/t coal
Sub-bituminous coal mined from underground mining	0.384	tCO_2e/t coal

From 2009 New Zealand Regulations

It is possible on the basis of data to propose a unique emission factor for a coal resource. Coal seam gas is not consistent across coal resources (as implied in Table 1) varying with:

- Coal rank
- Coal Type
- Depth of Burial
- Presence/ absence of old workings/ fractures etc that facilitate drainage

In the past, gas data was collected only for mining purposes, ie for designing ventilation in areas perceived likely to be underground mined. In the modern era the Buller coalfield has been predominantly mined by opencast methods, so data on gas content has been inconsistently gathered. Further, historically areas have been mined by underground methods facilitation gas drainage of coal, so gas hazards have not been a major concern.

Thus far one hole in the Deep Creek resource (DC40) has been tested for gas content ply by ply by Strata Geoscience personnel. The testing is undertaken using a hybrid method, where long desorption according to the USGS method is used (3 weeks time) to give the best indication of desorbable gas, followed by crushing of the coal to get a figure for residual gas.

The results for DC40 are tabulated below in Table 2. The lost and measured gas volumes are very low as a proportion, and even the residual gas is lower than would be expected for a coal of this rank in Greymouth where seams are deeper buried. The low gas volumes indicate substantial drainage over geological time and due to the historic underground workings.

It is understood that the ICCP standard to convert the gas volume to tCO_2e/t of coal uses the following constants:

- At 20°C (IPCC/ US EPA standard) the density of methane is assumed to be 0.67kg/m^3.

- The IPCC Global Warming Potential (GWP) conversion for fossil methane looks at the impact over 100-year horizon, with a multiplier figure of 29.8 versus CO_2 given (IPCC AR6 (Fossil Methane). Note over a 20 year timeframe, methane has an impact 80 times that of CO_2.

Table 2 – DC40 Gas Plus Calculations

	Lost Gas m^3/t	Measured Gas m^3/t	Residual Gas m^3/t	Total Gas m^3/t	Desorbable Gas m^3/t	Density Conversion kg	Convert to Tonnes	29.8x Desorbable
DC40 Can 1	0.01	0.01	0.22	0.24	0.02	0.161	0.000	0.0048
DC40 Can 2	0.01	0.05	0.19	0.25	0.06	0.168	0.000	0.0050
DC40 Can 3	0.00	0.00	0.20	0.20	0.00	0.134	0.000	0.0040
DC40 Can 4	0.00	0.00	0.30	0.30	0.00	0.201	0.000	0.0060
DC40 Can 5	0.00	0.02	0.33	0.35	0.02	0.235	0.000	0.0070
DC40 Can 6	0.03	0.02	0.36	0.41	0.05	0.275	0.000	0.0082
DC40 Can 7	0.02	0.06	0.23	0.31	0.08	0.208	0.000	0.0062
DC40 Can 8	0.02	0.02	0.28	0.32	0.04	0.214	0.000	0.0064
DC40 Can 9	0.03	0.02	0.24	0.29	0.05	0.194	0.000	0.0058
DC40 Can 10	0.01	0.03	0.29	0.33	0.04	0.221	0.000	0.0066
DC40 Can 11	0.01	0.05	0.36	0.42	0.06	0.281	0.000	0.0084
Average	**0.01**	**0.03**	**0.27**	**0.31**	**0.04**	**0.208**	**0.000**	**0.0062**
Min	0.00	0.00	0.19	0.20	0.00	use 0.67		use 29.8
Max	0.03	0.06	0.36	0.42	0.08			
SD	0.01	0.02	0.06	0.07	0.03			

Accordingly, using the conversion factors laid out by the ICCP, converting the methane measured in drillhole DC40 to CO2e gives figures ranging from 0.0040 to 0.0084, with an average of 0.0062 tCO_2e/t of coal. All the measured tCO_2e/t figures are substantially below the government nominal figure of 0.514 tCO_2e/t, indicating mining of coal from the Deep Creek area will emit much lower fugitive emissions than assumed in the regulations.

The data gathered in DC40 indicates further need to quantify gas content in coal from across the Buller Project resources.